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**EXPERIMENTAL STUDIES  
IN RECALL AND RECOGNITION**

BY  
**EDITH MULHALL ACHILLES, PH.D.**

**ARCHIVES OF PSYCHOLOGY**

EDITED BY  
**R. S. WOODWORTH**

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# EXPERIMENTAL STUDIES IN RECALL AND RECOGNITION

## CHAPTER I

### HISTORICAL SURVEY

MEMORY has been mentioned in literature for centuries, as Burnham<sup>1</sup> (5) has shown in his survey of the history of the subject. The first scientific study of the subject was in the time of Aristotle; his doctrines and conceptions as well as those of Plato, St. Augustine, Leibnitz, Bacon, Locke, Hume, Hartley, Kant and others, are interesting, but not until 1885 do we find a record of any experimental work. During the years 1879-80 and 1883-84 Ebbinghaus (7) performed upon himself a long series of experiments in memorizing nonsense syllables. Experimental researches on memory have continuously increased since Ebbinghaus published his results. Here will be considered those which have been concerned with the differences between recall or reproduction and recognition.

As methods of testing memory, reproduction and recognition were distinguished by Wolfe (17) in 1886. In studying the memory of tones he found it easier to use the method of recognition and rejected that of reproduction which Ebbinghaus had employed. Baldwin and Shaw (1), in determining the accuracy of the memory for the size of a square, used three different methods—(1) Selection from variety, (2) Identification, (3) Reproduction. Memory curves were made for these methods and found to be practically parallel, but the degree of accuracy much higher by the second method than by the first. In the method of reproduction the subjects after having seen the square were requested to draw it. The reproductions were always too small. Binet has published notes on the experimental study of memory to which Warren has referred. We quote in part: (1) Method of Reproduction—this consists in making the subject *reproduce* his impression; if it is a story that he has listened to, he repeats or writes it; if it is a visible form, he sketches it; if it is a sound or an inflection, or some visible movement, he imitates it; if it is a color, he reproduces it by mixing the tints on a palette or varying the sectors of rotating discs. This is certainly the most natural method, in that

<sup>1</sup> The numbers in parentheses refer to the list of References on p. 76.

it follows closely our ordinary procedure; but as a method of studying the memory it is somewhat indirect; it requires a translation or transposition of the impression, and a special aptitude, *e.g.*, in sketching or painting; it should, therefore, be expressly reserved for the verbal memory. (2) Method of Selection—this consists in the recognition of an impression when it is presented again in company with others; thus a tint is exhibited at first and the subject must remember it; at the end of a certain time he is shown a graded series of the same color, comprising 15 different tints, and must recognize the one which was shown him before; the second presentation may give the whole series simultaneously or successively. This method is simpler than the preceding, since it bears more directly on the memory; there remain to be considered the sources of error which it contains. Whenever we have to make a choice from among a set of objects our attention is drawn toward the center of the series; if the impression to be recognized is the sixth in a series of 15, the seventh impression is more apt to be indicated than the fifth, because the former is nearer the center; consequently the arrangement of the series exerts some influence upon the character of the results. (3) Method of Comparison—the subject compares the remembered impression with another impression which is shown him, and answers that the latter is “equal, greater, or smaller.” Kennedy (12) explains that in every experiment on memory there are of necessity two terms—*A*, a stimulus of some sort which constitutes the thing to be remembered, and *B*, an expression on the part of the reagent of the state of the memory of *A*. “The methods of experimental investigation of memory are to be distinguished from each other solely by the character of the *B* of the experiment. . . . The distinction between memory methods rests upon a difference between the general phenomena of memory, namely, those of reproduction and recognition. It is a well-known fact that former experiences are much more easily recognized than reproduced and that we understand many more words than we are able to use. As far as experimental methods are concerned, in reproduction we call up an old experience, unaided directly by any immediate expression from the outer world; while in recognition we simply feel the identity of a term already in consciousness with one which was there in the past. In the experiment itself this difference takes the following form. In the method of reproduction the subject, having been given some stimulus, is called upon after the lapse of a certain time to reproduce that stimulus without any further aid from the experimenter. . . . On the other hand, in the method of recognition, the subject, having been given the stimulus to be remem-

bered A, is again given one or more stimuli and required to pronounce upon the relation of identity which the latter holds (or hold) to the former. Thus the method of reproduction is to be distinguished from that of recognition by the fact that in the former only one artificially given stimulus is required in each experiment, while in the latter at least two are necessary."

Bean (2) says that the curve of forgetting can be properly measured by reproduction or recognition and that the rate of forgetting differs with the method.

Among the investigators to conduct experiments with the primary interest to determine the difference between recall and recognition is McDougall (13). He presented the material in two forms, first he exposed ten monosyllabic words simultaneously for a period of ten seconds to each of his two subjects. In the second case they were presented verbally. Afterwards the observers were asked to write down all that they could recall within a minute. Then from a set of twenty containing the original ten, they were requested to identify as many as possible. The difference in the per cent. recalled and recognized is about twenty. The results were as follows:

VISUAL		
Subject	Recall	Recognition
A .....	54.3%	69.7%
B .....	59.5%	84.3%
Average .....	<u>56.9%</u>	<u>77.0%</u>
AUDITORY		
A .....	50.0%	74.0%
B .....	57.0%	74.3%
Average .....	<u>53.5%</u>	<u>74.15%</u>

The data are too meager to draw any general conclusions, except perhaps that more can be recognized than recalled.

Heine (10) gave the recognition test by presenting the objects one at a time and asked the subject to state if each aroused a "distinct impression" of being known or if it was difficult to say, or if the impression was absent. The time of each was taken and the correct recognitions were quicker than the wrong or doubtful ones. Heine also found that retroactive inhibition had no effect on recognition, but did affect recall.

Strong (16) has used the recognition method extensively. One of the most noticeable results of experimental work is that recognition is easier than recall and has a higher score. Strong found that about 17 out of 20 words, after being presented once, could be recognized immediately afterwards; this is a much higher score than one



would expect for recall. Advertisements were shown by Strong one each second in sets varying in length from 3 to 150 and recognition tests were made immediately afterwards. The per cent. or relative amount recognized decreased with the increase in quantity shown, but the decrease was much slower than in the case of recall memory. For 150 the average per cent. recognized by forty subjects was 35 or about 52 words. This is a much higher score than one would expect by the recall method. Strong obtained the curve of forgetting for recognition. The general shape of the curve is similar to the one Ebbinghaus found for recall. The loss of memory is great at first and then proceeds more slowly.

When studying incidental memory Myers used sometimes recall, sometimes recognition, and sometimes both methods of testing according to which the material was best adapted. In connection with the testing of incidental memory for coins he writes: "The test was begun by merely having the circles 'drawn,' but at the suggestion of E. K. Strong, Jr., the recognition test was added and finally used alone. It is certainly preferable because of the time saved both in applying the test and in dealing with the results, though there is the disturbing element due to the large number of circles before the eye." Later when Myers (14) made a comparative study of recognition and recall, he drew the following conclusions:

"1. The recognition efficiency is about two and one half times that of recall, and this ratio varies slightly with different amounts of stimuli and with different intervals of time. However, the total number of words correctly scored in recognition was about four times the number recalled. The difference in ratios is due to the penalty assigned because of chance.

"2. Great individual difference obtains for both recognition and recall, but for recognition it was proportionately higher than for recall, and the difference of time intervals and length of stimulus affect the variability of recall more than that of recognition.

"3. The correlation between recall and recognition is surprisingly low: many who recall only one or two words or even a remarkably high record for recognition.

"5. For long intervals of time more of the answers for recognition are correct than those for recall and this superiority of recognition-answers increases with increase of time interval.

"7. The comparative order of frequency for each word, in recognition and recall is about the same for the first words of the list, but there is a wide variation for those least frequently recalled.

"9. The effective element is very much more pronounced in recognition than in recall.

"10. The wide difference in results obtained from the different groups under different conditions shows how unreliable it is to derive general laws from small groups of subjects arbitrarily tested. Therefore the conclusions herein derived are necessarily limited to the tests described in this study, until they shall have been verified by further studies.

"11. Some sex differences are obvious:

"(a) The girls are superior to the boys for both recognition and recall, and much more for recall than for recognition. Their superiority for recall invariably holds true even when divided into grades, while for recognition this superiority obtains only for large groups.

"(b) The most striking sex difference is shown in the ratio of recognition to recall; while on the average, the boys' efficiency for recognition is three times that of recall, the ratio by the girls is about two. Likewise the total gain in per cent., in recognition efficiency over that of recall is markedly superior for the boys.

"(c) A higher correlation between recall and recognition obtains for girls than for boys.

"(d) For recall the girls seem to be more variable than boys, while for recognition the opposite holds true.

"(e) The girls recall more incorrect words than the boys, while the boys recognize more incorrect words than the girls.

"(f) Both for recall and recognition a higher percentage of the total answers given by the girls than those given by the boys are correct."

Hollingworth (11) says "the difference between recall and recognition seems to be a rather simple matter. Recall is that aspect of memory process in which a setting, a background or association-cluster, is present in clear consciousness, but a desired *focal element* is missing. . . . Recognition is, schematically, just the reverse of this process. In recognition the focal element is present, in the form of sensation, image, or feeling, and the question is whether or not this element will recall a more or less definite general setting or background. . . . It is often said that recognition is an important part of recall memory, giving warrant to the correctness of the recalled element. This may often be the case, but it is not necessarily so. Items may be correctly recalled but not recognized as correct and rejected. Moreover, every case of recognition presumably involves recall or tendency to recall on the part of the setting. The ordinary

act of 'memory' is said to be complete when focal element and setting belong together, that is, mutually recall or sustain each other." He calls attention to several factors which appear to influence recall and recognition memory in different degrees, but draws only tentative conclusions due to the meager experimental data.

"An Experimental Investigation of Recognition and Reproduction" was published by Rybnikoff in 1914 in Russia. He says that the method of reproduction has been used to a great extent, probably due to the influence of Ebbinghaus, and that the method of recognition has been slightly developed. Although the title of the paper suggests an investigation in a comparison of the two processes, he uses, for the most part, recognition in his series of memory tests. Tests for reproduction were made in some cases, after the recognition test, by the *Treffermethode*. It is true that in the earlier researches on memory the method of reproduction was used. Recently, however, the investigations have employed recognition. Rybnikoff is to be praised for realizing the one-sided development, rather than adversely criticized for not being familiar with the recent work in recognition, as the recent researches in recognition had probably not reached the University of Moscow when Rybnikoff wrote.<sup>2</sup> Among the many researches on memory few have been concerned with recall and recognition as different methods of testing, notwithstanding their differences were pointed out early in the history of the experimental literature.

<sup>2</sup> The author wishes to express her thanks to the late Professor J. W. Baird, of Clark University, for his notes in English on the work of Rybnikoff.



## CHAPTER II

### THE PROBLEM STATED

DIFFERENT problems in the field of the experimental work on memory have been examined. Often the data of various investigators on similar problems have been apparently incomparable due to the difference in methods of testing memory. For some time it has been known that one can recognize more items than one can recall, but it has not been known whether the recognition memory can be stated as two, three or four times the recall memory, or whether the position at the beginning or end of a list, or other factors, will influence recognition as much as they do recall. There are no data to prove that one who recalls well can also recognize well; nor whether the results which exist for one material, *i.e.*, words, would be equally evident for another material, *i.e.*, nonsense syllables or geometrical forms.

The present investigation has been primarily designed to examine the similarities and differences in the two methods of testing, reproduction and recognition. The questions which it has aimed to answer are:

1. What is the equivalence of repetitions in Recall and Recognition of different materials?
2. Does the factor of determination to remember influence recall and recognition in the same way?
3. Does primacy effect recall? — recognition?  
“ recency “ “ “  
“ color “ “ “  
“ size “ “ “
4. Does the person who recalls one material well also recognize that material well? Is the answer the same for different materials? Is it true for both adults and children?
5. Does the person who recalls one material well also recall another material well? Is the answer the same for both adults and children?
6. Does the person who recognizes one material well also recognize another material well? Is the answer the same for adults and for children?
7. Is a material which is recalled well also recognized well?

8. Are there any sex differences in achievement among the adults in recall?—in recognition?

9. Are there any sex differences in variability among the adults or among the children in the recall of the different materials?—in the recognition of the different materials?

10. Is there any difference in recall among the children of the same age regardless of class in school?—in recognition?

11. Is there any difference in recall among the children of the same grade regardless of age?—in recognition?

12. Is there any difference in the amount recalled or recognized by children, college students, and graduate students?

13. Do tests for recall and recognition on insane subjects, who have memory defects, reveal any characteristic differences between the methods?

## CHAPTER III

### PRELIMINARY EXPERIMENTS

FURTHER experimental investigation into the relation of the two memory processes, recall and recognition, was stimulated by Hollingsworth's article on "Characteristic Differences between Recall and Recognition."<sup>1</sup> His title suggests that there are two differences, but his conclusions are only tentatively drawn, due to the meager data. To add to the data on points which he raised was the purpose of these preliminary experiments.<sup>2</sup> The first questions asked were:

1. What is the equivalence of repetitions for recall and recognition?
2. What is the influence of the factor of determination to remember on recall and recognition?
3. What is the effect of the factors of primacy and recency?

#### 1. *Equivalence of Repetitions*

"It is, of course, a matter of common experience that a single presentation may suffice to enable recognition but be quite insufficient to make recall possible," says Hollingsworth. The experiments of the present writer were designed to determine the difference in the number of repetitions necessary for the mastery of fifteen items for four materials, pictures of objects (lamp, fish, clock, etc.), geometrical forms, words (chair, hammer, car, doll, etc.) and nonsense syllables (fik, vod, deb, ruz, biv, etc.).

"Mastery" was measured for both recall and recognition. Each subject was shown fifteen words successively at regular intervals of two seconds each and then required to write those he remembered; in the case of the pictures of objects, the name of the object was written. A set of thirty (30) containing the original fifteen (15) was given to the subject from which he was to select fifteen which he thought were in the original set. The first set of fifteen was presented again as before and the subject was requested to recall those

<sup>1</sup> Hollingsworth, H. L. "Characteristic Differences between Recall and Recognition," *Amer. J. of Psych.*, 1913.

<sup>2</sup> Mulhall, Edith F. "Experimental Studies in Recall and Recognition," *Amer. J. of Psych.*, 1915.

he could and then to select fifteen from the thirty set. This was repeated until he was able to recall and recognize the fifteen items correctly. The same experiment was performed for all four materials on twenty-five subjects, all undergraduate or graduate students in Columbia University.

Table I shows the average number of repetitions necessary for complete recall and complete recognition, and the ratio of the two for all materials.

TABLE I

Material	Process	Av. No. Repetitions	M. V.	Ratio Av. for Recall to Av. for Recog
Pictures .....	Recall .....	3.36	.79	3.23
	Recog .....	1.04	.08	
Forms .....	Recall .....	3.96	.85	2.20
	Recog .....	1.80	.81	
Words .....	Recall .....	4.76	1.61	1.80
	Recog .....	2.64	.96	
Syllables .....	Recall .....	7.12	2.23	1.22
	Recog .....	5.80	2.11	

The data indicate that the difference between recall and recognition memory is greatest for pictures, somewhat less for forms and words, and least for nonsense syllables. The number of repetitions required for both recall and recognition is least for pictures, greater for forms and words, and greatest for syllables. In examining the materials one finds that the pictures offer the greatest richness of associations. The forms offer somewhat fewer advantages—the shape can be visualized, in a few cases they can be named, and associations, but few in number, can be made. The third material, words, all being nouns, are names and have associations, but lack any particular picture or form element. The syllables, as their name implies, are nonsense; most, if not all, are devoid of any association. Introspections of the subjects indicate that association was employed as an aid in memorizing.

The following secondary experiment shows this more definitely. To each of two subjects a mixed set of sixteen items (four pictures, four forms, four words, four syllables) was presented, one unit every two seconds. Careful introspections were called for as each item was afterwards recalled. The subjects were also required to select sixteen from a set of thirty-two (eight of each material). A few of the records are given as examples of the means the subjects used to aid memory.

*Pictures Remembered*

*Why and How*

- butterfly ..... Benefit performance of Madam Butterfly to be given for the College.
- car ..... Its many uses, with engine, auto, etc.
- coat ..... Livery.
- bridge ..... A particular bridge in Sullivan County.
- lamp ..... Toaster received yesterday which I connected to a lamp.
- nuts ..... Walnuts I bought to-day.

*Words*

- tree ..... Curious tree examined on a recent walk.
- knife ..... Bread.

*Syllables*

- naf ..... Nap.
- jod ..... Jodl, psychologist.

*Forms:* The forms reminded the observers of "a diamond," "a wind-mill," "exclamation point," "color disc," "pie," and "kindergarten shapes."

The introspections of both subjects show clearly the method of association in recalling the material and the difficulty and often inability of remembering material with few or no associations.

Since the greatest difference in recall and recognition memory is for pictures when the material has an abundance of association, less for forms and words, and least for syllables where associations are respectively less, it appears that the difference in recall and recognition memory is in part dependent on the richness of associations present.

*2. Influence of Determination to Remember*

Hollingworth's data on this point were gathered in an experiment in which each of five observers performed the "opposites" test 60 to 75 times. The task was to speak the opposite of each of fifty adjectives as quickly as possible. One or two trials were made each day but the order of the list was changed. After 60 to 75 trials each observer was asked to reproduce all the pairs of opposites that had been used. Recognition was tested by presenting one hundred pairs of opposites, containing fifty new pairs and the fifty original ones, and asking the observer to identify the original fifty. The results were:

	Rc. in 3 Min.	Rc. in 15 Min.	Rg. in 3 Min. or Less
Average of five observers .....	14.8	28.8	49.6



from which Hollingworth concludes: "It is not possible, on the basis of these figures, to say that recognition is not influenced by the presence or absence of the determination to remember, but it is clear that it is much less influenced by this factor than is the process of recall." No control experiments in which determination was employed were made and no definite conclusions about the influence of this factor can be drawn. The recognition score is about perfect, but the presence of this 100 per cent. recognition efficiency when no determination to remember was present, does not indicate that determination could have exerted no influence, if it had been present, but that it would have had no opportunity to show its influence or lack of influence in the scoring, since 100 per cent. is maximum efficiency.

To gather further data on the influence, if any, of intention to remember on recall and recognition two groups of twenty-five subjects each were tested. Twenty (20) photographs (15 men, 5 women) with names attached, and fifteen syllables were the two kinds of material used, one rich with associations, the other devoid of them. The first twenty-five subjects were asked to take part in an experiment in judgment. Each subject read the following instructions:

"Arrange the 15 nonsense syllables in four piles according to ease of articulation. You will be given two minutes to do this,"

and was given a set of fifteen (15) cards on each of which was typewritten one syllable, and four cards labeling the four piles, "Very Easy," "Fairly Easy," "Slightly Easy," "Indifferent." If the arrangement was made before the two minutes had expired the subject was urged to make sure the arrangement was satisfactory. At the end of the two minutes the observer was asked to make a record of the syllables in each pile on the blank provided.

Twenty photographs with names attached and four cards labeling the piles "Very Attractive," "Fairly Attractive," "Slightly Attractive," "Indifferent," were given to each observer with the following instructions:

"Arrange the 20 pictures in four piles as indicated. You will be given 2 minutes to do this."

After the two minutes had expired each subject was requested to record the names of the pictures in each pile on the blank provided. This was done to make sure the subject looked at the names under the pictures.

The subject's memory for both materials was tested. Three minutes were given for the recall of the syllables and then a selection of fifteen from a set of thirty, fifteen of which were in the original set, was made. The observer was asked to recall the names of

photographs in three minutes. A set of forty photographs, twenty being those of the original set without names, was provided with the following directions:

“Select 20 pictures from this group which you think were previously shown. Name any which you can.”

After the subject had selected the photographs, a set of forty cards on each of which was typewritten a name (twenty were the names attached to the photographs in the original set, twenty were other names) was used for the recognition of names. Care was taken not to repeat any name, either first or last, nor to use the last name of any well-known person.

The second group of twenty-five subjects first copied the list of syllables and names on the pictures. This was done in order to control the conditions, keeping them, as far as possible, identical with those of the first group. If such a record had not been required for the group which was judging, one could not be sure that the subjects read the names. Even with this precaution, the subjects claimed they had never looked at them, until reminded they had written each on the blank.

After making these copies, the subjects of the second group were given a set of fifteen nonsense syllables with these instructions:

“You will be given 2 minutes to look at these 15 syllables. Later you will be called upon to remember them, so look at each with a *determination to remember it.*”

After two minutes had expired, the set of photographs was presented with the directions:

“You will be given 2 minutes to look at these 20 pictures. You will afterwards be called upon to remember the names and photographs, so look at each with a *determination to remember.*”

Recall and recognition were tested in the same way as for the first group.

Throughout the experiment an attempt was made to keep the conditions for both groups the same. Any sources of error or awkwardness in conducting the experiment, due to the difficulty of keeping the observers of the first group ignorant of the purpose of the investigation, which may give rise to criticism, will be found to be constant for both groups.

The purpose of the experiment was (1) to compare recall memory, with and without determination to remember, with recognition, with and without determination to remember, respectively; (2) to compare recall and recognition with determination and recall and recognition with no factor of determination present; and (3) (a) to

compare recall of syllables, with and without the intention to remember, with recall of names with and without determination, and (b) to compare recognition of syllables with and without the intention to remember with recognition of photographs and names with and without the intention to remember.

In Table II. the total number recalled and recognized by both groups is given for both materials. Table III. shows the ratio of recall with a determining factor present to recall with no such factor present and the ratio of recognition with a determining factor to recognition without the determining tendency for both materials. Table IV. gives the ratio of recognition with determination to recall with determination and the ratio of recognition without determination to recall without determination for both materials.

TABLE II  
SYLLABLES

	No Determination		Determination	
	Recall	Recog.	Recall	Recog.
Total .....	126	318	155	326
Average .....	5.0	12.7	6.20	13.0
M.V. ....	1.65	1.26	2.06	.73

PHOTOGRAPHS AND NAMES

	No Determination			Determination		
	Recall	Recog. N.	Recog. Ph.	Recall	Recog. N.	Recog. Ph.
Total .....	77	391	461	134.5	435	415
Average .....	3.08	15.6	18.4	5.36	17.4	16.6
M.V. ....	.90	1.53	1.48	1.57	1.44	1.90

TABLE III  
SYLLABLES

Ratio of Determined Recall to Undetermined Recall ..... 100: 81.3  
 Ratio of Determined Recog. to Undetermined Recog. .... 100: 97.5

PHOTOGRAPHS AND NAMES

Ratio of Determined Recall to Undetermined Recall ..... 100: 57.2  
 Ratio of Determined Recog. to Undetermined Recog. .... 100: 100.2

TABLE IV  
SYLLABLES

Ratio of Determined Recog. to Determined Recall ..... 100: 47.55  
 Ratio of Undetermined Recog. to Undetermined Recall ..... 100: 39.62

PHOTOGRAPHS AND NAMES

Ratio of Determined Recog. to Determined Recall ..... 100: 15.82  
 Ratio of Undetermined Recog. to Undetermined Recall ..... 100: 9.03



Since some subjects might recognize more names than photographs and others more photographs than names, the score for recognition includes the number of photographs and names recognized.

TABLE V

Ratio of Det. Rc. of SYLLABLES to Det. Rc. of NAMES .....	100: 86.8
Ratio of Undet. Rc. of SYLLABLES to Undet. Rc. of NAMES .....	100: 61.1
Ratio of Det. Rg. of SYLLABLES to Det. Rg. of NAMES and PHOTO- GRAPHS .....	100: 260.6
Ratio of Undet. Rg. of SYLLABLES to Undet. Rg. of NAMES and PHOTO- GRAPHS .....	100: 267.9

In Table V. the materials are compared. The ratios of recall of syllables to recall of names are presented with no determination and with determination to remember; the ratios of recognition of syllables to recognition of photographs and names with and without determination to remember are also stated.

It will be noticed that fewer photographs were recognized when there was a determination to remember present, but many more names. This does not mean that determination to remember decreases one's ability to recognize faces. The larger number of names recognized with determination to remember seems to indicate that the observers considered names more difficult to remember and spent most of the time allotted to them to learn names. The total number of photographs and names recognized with determination to remember was 850 and without 852, or an average in each case of 34 items. Throughout, the calculations involving the recognition of the material with greater meaning the totals 850 and 852 have been used. Frequently a subject could recall the first or last name but not both; in each case the score of one half was given (Table VI.).

TABLE VI  
RECALL OF NAMES

	No Determination			Determination		
	1st Only	2d Only	Both	1st Only	2d Only	Both
Total .....	40	50	32	49	62	79
Total first names .....		72			128	
Total last names .....		82			141	

The data indicate the following: (1) the factor of determination to remember influences recall memory, but its effect on recognition is little, if any; (2) the difference between recall and recognition is less when there is a determination to remember the material than when there is no intention to remember; (3) the influence of deter-

mination for the recall of names is greater than for the recall of nonsense syllables; there is little, if any effect of determination to remember on the total number of items recognized of either material.

A further study of the data for the recall of names shows interesting results. When no determining factor was present 72 first names were recalled and with determination 128, or an increase of 77 per cent.; with no determination to remember 82 last names were recalled, with intention present 141, or an increase of 72 per cent.; with no determination total number recalled 77 and with determination 134.5, or an increase of 75 per cent. Determination to remember seems to influence the recall of first and last names to the same degree. Determination to remember influences greatly the number of first and last names correctly connected, as there were only 32 with no determining factor and 79 with one, or an increase of 147 per cent. Moreover, the determining tendency influences the number of photographs which may be correctly named. Table VII. shows

TABLE VII  
NAMES CORRECTLY ASSOCIATED WITH PHOTOGRAPHS

	No Determination				Determination			
	1st	2d	Both	Total	1st	2d	Both	Total
Total . . . . .	2	9	13	18.5	10	24	48	65.0
Highest score . . .	1	3	4	4	3	4	7	8
Lowest score . . .	0	0	0	0	0	0	0	0

the number of first, last, and whole names which were correctly assigned to the photographs for both groups of subjects. According to the method of scoring adopted, 18.5 names were correctly given to the photographs by the first group and 65 by the second.

The data seem to indicate that

Determined recall differs from undetermined recall more than determined recognition differs from undetermined recognition.

The difference between determined recall and determined recognition is less than that between undetermined recall and undetermined recognition.

The influence of a determining factor is greater for recall of material rich with associations than for material devoid of them.

The determining factor influences the amount of material remembered which can be correctly associated with other material remembered.

### 3. *Primacy and Recency*

The third part of the investigation was concerned with determining the influence of primacy and recency on recall and recognition.

Ninety-one subjects were tested for two materials, nonsense syllables and photographs. To nineteen, a list of twenty-four nonsense syllables was presented at the rate of one item every two seconds in a given order (nos. 1-24). Immediately after the presentation they were asked to recall all they could in three minutes and then were given a list of forty-eight from which to select 24 which they thought had been previously presented. The subjects were then shown twenty-four pictures at the rate of one every two seconds. As each was presented a name was pronounced by the experimenter. Immediately after the presentation, they were given three minutes in which to recall the names. A set of forty-eight photographs, containing the original twenty-four, was used for the recognition test. Each subject was then provided with a list of forty-eight names from which to select twenty-four which he thought had been pronounced

TABLE VIII

## PRIMACY AND REGENCY

*Material: Syllables. Process: Recall*

Order of Presentation	Total 1-24	Total 13-24, 1-12	Total 7-24, 1-6	Total 19-2 1-18	Grand Total	Per Cent. of Av.
1	11	12	10	22	55	206.2
2	8	8	8	8	32	119.9
3	9	10	3	8	30	112.5
4	10	4	2	12	28	104.9
5	2	7	3	3	15	56.2
6	6	4	11	8	29	108.3
7	1	6	8	3	18	67.5
8	2	0	5	5	12	44.9
9	6	4	10	7	27	101.2
10	3	5	1	11	20	74.9
11	4	4	10	4	22	82.5
12	3	3	2	5	13	48.7
13	9	2	10	6	27	101.2
14	1	10	7	3	21	78.7
15	5	4	3	4	16	59.9
16	3	7	7	15	32	119.9
17	5	1	2	8	16	59.9
18	3	2	6	6	17	60.4
19	8	2	4	15	29	108.3
20	4	6	10	8	28	104.9
21	1	5	3	12	21	78.7
22	8	11	7	7	33	120.3
23	3	8	12	17	40	149.9
24	9	12	21	16	58	217.5
No. of Subjects	19	19	25	28	91	
Total					639	
Average per position				26.67	100	

TABLE VIII (Continued)

## PRIMACY AND REGENCY

*Material: Syllables. Process: Recognition.*

Order of Presentation	Total 1-24	Total 13-24, 1-12	Total 7-24, 1-6	Total 19-24 1-18	Grand Total	Per Cent. of Av.
1 .....	17	19	20	27	83	140.0
2 .....	17	17	18	23	75	126.5
3 .....	15	19	15	22	71	119.7
4 .....	16	11	16	26	69	116.4
5 .....	14	18	20	19	71	119.7
6 .....	10	9	18	25	62	104.6
7 .....	15	15	20	23	73	123.1
8 .....	16	12	12	23	63	106.2
9 .....	13	16	20	17	66	111.3
10 .....	13	13	10	20	56	94.4
11 .....	13	15	25	19	72	121.4
12 .....	11	16	7	11	45	75.9
13 .....	15	15	17	16	63	106.2
14 .....	11	15	16	15	57	96.1
15 .....	10	9	16	22	57	96.1
16 .....	9	14	19	23	65	109.6
17 .....	17	11	13	24	65	109.6
18 .....	12	8	17	16	53	89.4
19 .....	14	13	17	23	67	112.9
20 .....	9	11	17	14	51	86.0
21 .....	13	9	16	23	61	102.9
22 .....	16	16	15	12	59	99.5
23 .....	7	15	17	23	62	104.6
24 .....	18	13	13	14	58	97.8
Total .....	321	329	394	480	1424	
No. of Subjects .....	19	19	25	28	91	.
Average per position .....				59.33	100	

as the pictures were presented. The experiment was repeated on the second group of nineteen, but the order of each material was 13 through 24, 1 through 12; and on a third group of twenty-five and on a fourth group of twenty-eight subjects, where the orders were 7-24, 1-6 and 19-24, 1-18 respectively.

The results were calculated according to the position of the item, *i.e.*, for position one the record is given for the number of times item 1 was remembered by members of the first group, item 13 by those in the second group, item 7 by those in the third group, and item 19 by those in the fourth. For position two the record is given for item 2 by the first group, item 14 by the second group, item 8 by the third, and item 20 by the fourth; and so on until position twenty-four shows the number of items 24, 12, 6, 18, were remembered by groups one, two, three, and four respectively.

TABLE IX

*Material: Names. Process: Recall.*

Order of Presentation	Total 1-24	Total 13-24, 1-12	Total 7-24, 1-6	Total 19-24, 1-18	Total	Per Cent. of Av.
1	2.7	1.5	4.5	3.5	11.5	55.0
2	0	0	2.0	9.0	11.0	52.6
3	2.5	3.5	5.5	9.0	20.5	98.0
4	1.0	2.0	5.5	7.5	16.0	76.5
5	.5	3.0	6.5	10.5	20.5	98.0
6	2.5	1.5	9.0	5.5	18.5	88.5
7	1.0	1.5	6.5	5.0	14.0	67.0
8	.5	4.0	1.5	4.0	10.0	47.8
9	1.0	1.5	13.0	13.5	29.0	138.7
10	1.5	2.0	3.0	7.0	13.5	64.6
11	2.0	2.5	6.0	4.0	14.5	69.3
12	.5	1.5	5.5	5.0	12.5	59.8
13	5.5	2.0	2.0	2.5	12.0	57.9
14	.5	0	10.5	2.0	13.0	62.2
15	4.5	4.5	6.5	4.0	19.5	93.3
16	2.0	2.0	8.0	2.5	14.5	69.3
17	2.5	1.5	14.5	3.0	21.5	102.9
18	1.5	2.0	7.5	9.5	20.5	98.0
19	1.0	1.0	7.0	7.5	16.5	78.9
20	6.0	.5	2.5	5.0	14.0	67.0
21	2.5	2.5	7.5	9.5	22.0	105.2
22	7.5	3.5	8.0	11.5	30.5	145.9
23	7.0	13.0	10.5	14.5	45.0	215.3
24	11.5	19.0	23.0	28.0	81.5	390.0
Total	67.0	76.0	176.0	183.0	502.0	
No. of Subjects	19	19	25	28	91	
Average per position						20.9 100

TABLE IX (Continued)

*Material: Photographs. Process: Recognition*

Order of Presentation	Total 1-24	Total 13-24 1-12	Total 7-24 1-6	Total 19-24 1-18	Total	Per Cent. of Av.
1 .....	11	16w	12	14	53	98.9
2 .....	11	8	16	19	54	100.7
3 .....	14w	14w	17	14	59	110.0
4 .....	3	15	11	22w	51	95.2
5 .....	9	11	15	25	60	111.8
6 .....	11w	11	12	21	55	102.6
7 .....	10	10	11w	17	48	89.6
8 .....	15	17	15	11	58	108.2
9 .....	13	7	17w	25w	62	115.7
10 .....	4	12w	16	17	49	91.4
11 .....	14	13	10	13	50	93.3
12 .....	4	13	17	23w	57	106.3
13 .....	16w	12	14	18	60	111.8
14 .....	7	8	17	17	49	91.4
15 .....	10w	16w	15	18	59	110.0
16 .....	10	3	18w	8	39	72.7
17 .....	15	10	19	19	63	117.5
18 .....	12	13w	13	10	48	89.6
19 .....	10	14	15	26w	65	121.3
20 .....	15	14	9	10	48	89.6
21 .....	4	11	21w	20w	56	104.5
22 .....	13w	5	10	19	47	87.7
23 .....	17	15	9	10	51	95.2
24 .....	10	3	11w	21	45	83.9
Total .....	258	271	340	417	1286	
No. of Subjects .....	19	19	25	28	91	
Average per position .....				53.6	100	
(w indicates photograph of a woman.)						



TABLE IX (Continued)

*Material:* Names. *Process:* Recognition.

Order of Presentation	Total 1-24	Total 13-24 1-12	Total 7-24 1-6	Total 19-24 1-18	Total	Per Cent. of Av.
1	18	13	20	21	72	105.4
2	6	8	18	28	60	87.8
3	16	18	17	24	75	109.8
4	15	15	22	21	73	106.9
5	12	17	21	27	77	112.7
6	14	15	23	22	74	108.3
7	18	12	16	25	71	103.9
8	6	18	9	26	59	86.4
9	12	12	24	28	76	111.1
10	9	13	23	26	71	103.9
11	13	11	23	19	66	96.6
12	12	12	20	20	64	93.7
13	14	12	16	21	63	92.2
14	7	12	24	11	54	79.0
15	16	15	22	20	73	106.9
16	10	13	17	20	60	87.8
17	11	11	23	21	66	96.6
18	11	11	22	22	66	96.6
19	9	12	22	21	64	93.7
20	18	11	17	18	64	93.7
21	9	11	21	23	64	93.7
22	14	10	22	27	73	106.9
23	19	16	21	23	79	115.7
24	15	18	18	24	75	109.8
Total	304	316	481	538	1639	
No. of Subjects	19	19	25	28	91	
Average per position				68.20	100	

Primacy and recency both influence recall memory. The influence of each on recognition is less than on recall, but is greater for material devoid of associations and less for material rich with associations.

#### 4. Variations in Size and Color

Peterson (15) studied the influence of complexity and dissimilarity on memory. Among other interesting facts, he determined the effect of variations in size and in color for recall. His results suggest the questions:

4. What is the influence of variation in color on recall and on recognition?

5. What is the influence of variation in size on recall and on recognition?

Peterson and Gordon experimented on series of nine nonsense syllables. Although it was desirable to make the conditions of the present experiments as nearly the same as possible as in these authors', longer series were necessary to insure exceeding the subjects' recognition ability for a perfect score. Sixteen syllables were used in each series. Four colors (red, green, blue, yellow) were presented each four times in the series to give the variation in color. The letters were cut from Hering papers the size of Willson's Gummed Letters No. 21, one half inch high; and one syllable of three letters of the same color was pasted on cards  $4 \times 6$  inches. For the size variation the black Willson Gummed Letters  $\frac{1}{8}$ ,  $\frac{3}{8}$ ,  $\frac{1}{2}$ , 1,  $1\frac{1}{2}$  inches high were used. On each card was pasted one syllable, each letter in the syllable being the same size. The size of syllable varied in the series in the following order:  $\frac{1}{8}$  in.,  $\frac{3}{8}$ ,  $\frac{1}{2}$ , 1,  $1\frac{1}{2}$ , 1,  $\frac{1}{2}$ ,  $\frac{3}{8}$ ,  $\frac{1}{8}$ ,  $\frac{3}{8}$ ,  $\frac{1}{2}$ , 1,  $1\frac{1}{2}$ , 1,  $\frac{1}{2}$ ,  $\frac{3}{8}$  inches. The standard series for both color and size were in black letters one half inch high. Four series were presented to each subject, one varied in color, one in size, two were in black.

Each subject was tested separately. One item in the series of sixteen was shown every two seconds; recall and recognition tests were made as in the previous experiments. The forty subjects were divided into four groups of ten each, designated by the letters *A*, *B*, *C*, *D*. The different series may be represented by the Roman figures I., II., III., IV. The addition of "color" or "size" to a numeral indicates that the series varies in color or size respectively. To Group *A* the material was presented in the following order: I. Color, II., III. Size, IV., *i.e.*, for Group *A* the first series was varied in color, the second was all black, the third varied in size, and the fourth was in size one half inch high. To Group *B* the material was presented in the order I., II. color, III., IV. size. Thus what was "standard" for Group *A* was "varied" for Group *B* and what was "varied" for Group *A* was "standard" for Group *B*. The score of series I. color for Group *A* and series II. color for Group *B* compared with the score of II. for Group *A* and I. for Group *B* shows the influence of color, as such, on the memory of these nonsense syllables. The score of III. size for *A* and IV. size for *B* compared with IV. for *A* and III. for *B* shows the influence of size variation for these series. In these two groups, *A* and *B*, the recognition set was similar to the presentation series, *i.e.*, if a presentation series varied in color, the recognition set had thirty-two items, eight red, eight yellow, eight blue, eight green; if the presentation series varied in size, the recognition set contained thirty-two items, four of size  $\frac{1}{8}$  inch, eight  $\frac{3}{8}$



inch, eight  $\frac{1}{2}$  inch, eight 1-inch, four  $1\frac{1}{2}$  inch. It is difficult to secure material absolutely devoid of meaning, for, as Morton Prince has said, "Even nonsense syllables have the meaning nonsense."<sup>1</sup> The materials used in this part of the experiment were almost entirely devoid of associations. No syllable was repeated; the series were so devised that no syllable in red had the letter R in it, no syllable in yellow had a Y, none in blue had a B, nor had any in green a G. None of the letters in one syllable appeared in the next syllable in the series. All the letters were capitals; the use of capitals made the syllables more nonsensical and less easy to associate.

The presentations to Groups C and D resembled those made to Groups A and B respectively. The recognition series differed; to Groups C and D the recognition sets were always standard, *i.e.*, black size  $\frac{1}{2}$  inch. The records for all groups are given in Table X. It will be noticed that the recall records for Groups A and C and for Groups B and D respectively can be combined.

Peterson writes "In immediate recall the series varying in size gave slightly better results than the standard—a gain of 9 per cent., but that color variation was of no aid." His table shows:

	Immediate Recall	
Average for standard .....	6.31	M.V. 1.15
Average for color variation .....	6.35	M.V. .74
Average for size variation .....	6.89	M.V. .68

The results of the present experiment show:

	Immediate Recall (40 Subjects)	
Average for standard .....	2.70	M.V. 1.22
Average for color variation .....	2.58	M.V. 1.02
Average for standard .....	2.63	M.V. 1.25
Average for size variation .....	2.75	M.V. 1.23

Tables X., XI. show the results for both recall and recognition. Color variation does not increase the amount recalled or recognized so far as these experiments are concerned. The variation in size of the syllables does not affect recall or recognition. Color and size variation, as such, present in this meaningless material, did not influence either recall or recognition.

In the study of the possible influences which these factors might have upon recall and recognition no characteristic differences between the processes are noticed. A factor which may have shown a tendency to influence recall in one way showed the tendency in the same direction for recognition, although the extent or degree of the influence may have differed. To study the relation of the processes in different materials and among different groups of subjects was the purpose of the experiments discussed in the following chapters.

TABLE X

RECALL			
<i>A</i> II. ....	19		
<i>B</i> I. ....	27	46	
<i>C</i> II. ....	31		
<i>D</i> I. ....	31	62	
Total (40 subjects) .....	108		
Average .....	2.70		2.58
M.V. ....	1.22		1.02

RECOGNITION

<i>A</i> II. ....	100		
<i>B</i> I. ....	114	214	
<i>C</i> II. ....	104		
<i>D</i> I. ....	119	223	
Total (40 subjects) .....	437		
Average .....	10.93		
M.V. ....	1.34		
Presented in black, recognition in black ..... Av. 10.93 (40 subjects)			
Presented in color, recognition in color ..... Av. 10.80 (20 subjects)			
Presented in color, recognition in black ..... Av. 10.65 (20 subjects)			

TABLE XI

RECALL			
<i>A</i> III. (size) .....	28		
<i>B</i> IV. (size) .....	25	53	
<i>C</i> III. (size) .....	28		
<i>D</i> IV. (size) .....	29	57	
Total (40 subjects) .....	110		
Average .....	2.75		2.63
M.V. ....	1.23		1.25

RECOGNITION

<i>A</i> III. (size) .....	110		
<i>B</i> IV. (size) .....	109		
Total (20 subjects) ....	219		
Average .....	10.95		
M.V. ....	.97		
<i>C</i> III. (pre. size) ..	107		
<i>D</i> IV. (pre. size) ..	110		
Total (20 subjects) ....	217		
Average .....	10.85		
M.V. ....	1.30		
Presented in standard, recognition set standard ..... Av. 10.68			
Presented in variation, recognition set standard ..... Av. 10.85			
Presented in variation, recognition set variation ..... Av. 10.95			

## CHAPTER IV

### METHODS AND PROCEDURE

#### 1. *Materials*

THE foregoing experiments seem to indicate that the degree of difference between recall and recognition, when different factors are present, varies with the material used. In general, if there is any noticeable difference in the influence of a factor on recall and recognition, it is greater for material rich with association. In the present study four kinds of materials are used; words, geometrical forms, proverbs, and nonsense syllables. There are twenty-five items of each material in the presentation series and fifty in the recognition series. The words are all simple nouns—hand, chicken, letter, coal, umbrella, kite, etc. The forms are similar to those employed by Whitley and later by Simpson. Proverbs were collected for several months before the experiment was begun, by noting all the proverbs seen or heard and by reference to collections of proverbs. It was desired to have all the proverbs “reasonably short” and “about the same length”—*i.e.*, the proverb must take only one line on the card and must not be so much longer than the one above or below it to be easily recognized on the recognition blank on account of size. The attempt was made to have as many proverbs that might be familiar as those that might not be so familiar in the presentation and control series. Among the proverbs used are: “Enough is as good as a feast,” “No road is long with good company,” “Pleasing everybody is pleasing nobody.” The nonsense syllables used have three letters, the first and the last being consonants and the middle one a vowel—zof, dej, zaf, etc. The series are printed in small letters but made as devoid of associations as possible—none of the letters in a syllable appeared in the syllables above or below it in the list.

There are two presentation series and two recognition series for each material, except words for which there are four series. The items for each material, except forms, are printed in a single column on a separate card in type, Eight Point Scotch; each card is headed by the word WORDS or PROVERBS or SYLLABLES according to the material. The twenty-five forms are printed in five rows of five items each on a separate sheet. For the recognition tests fifty items of each material, twenty-five being the same as in the presentation series,

are printed in two columns (one column for proverbs) in the same type on separate blanks.

In the tests for children the only materials used are words, forms and syllables. Proverbs are included in the adult tests as it is desired to have a material for which the subjects might have a wealth of associations. This material is not used for children as it is probably not familiar to them. Some of the younger children read slowly and could not finish reading the list of proverbs in the given time.

The selection of the number of items and the time allowed for study are based on previous experiments. It is desired to have the series of all the materials the same length, and long enough that none or few persons tested would have a perfect score for recognition. Of the 734 persons tested one had a perfect score.

For clearness in the later discussion we shall call the first set presented *A* and the second *B*. The first items in the series for words, proverbs, syllables, words, for set *A* are flag, A rolling stone gathers no moss, qoh, glove respectively and for Set *B* hand, Make hay while the sun shines, zof, steeple, respectively.

## 2. *Methods of Scoring*

When recall memory has been tested by other investigators the method of scoring by items has been to credit the subject with a unit for each item remembered—*i.e.*, if he recalls five words or syllables his score is 5, if six times, 6, and so on. Washburn has scored  $\frac{2}{3}$  when two out of three letters in a nonsense syllable are recalled. One may question if it is not a more difficult task to remember one more item after having learned ten, than one more after having learned five, but it is customary in experimental studies in recall when scoring in terms of items (not time) to call the first record 11 and the second 6, thus giving the extra item in each case the score of 1. This method of scoring does not need empirical formulæ and gives a simple system. The use of percents in scoring recall is often misleading. If *X* has Recall Score 10, 25 words having been presented, he has recalled 40 per cent., *Y* has Recall Score 5 and has recalled 20 per cent., but is *X*'s memory twice as good as *Y*'s? We should not say it necessarily is. Again, *M* has score of 11 and *N* a score of 6—*M*'s score in terms of percents is 44 per cent. of the total, *N*'s score is 24 per cent.; *M*'s score 4 per cent. greater than *X*'s score, and *N*'s score 4 per cent. greater than *Y*'s score. Is the difference between *X*'s and *M*'s memory the same as that between *Y*'s and *N*'s? We should not say it necessarily is. Percents in the scoring of recall memory are often misinterpreted. Throughout this report



the meanings of "Recall Score 5" and "Recall Score 10," etc., are "5 items recalled correctly out of 25" and "10 items recalled correctly out of 25," etc., respectively.

In the experiments reported in the foregoing chapters the recognition score is the number recognized correctly when the subjects are required to select a certain number (number originally presented). This method has been criticized adversely because it is thought that the "guessing" factor is not sufficiently controlled. Strong (16) has devised a formula,

$$\frac{\text{Correct recognitions}}{\text{Total number presented}} \times \frac{\text{Correct recog.} - \text{Incorrect recog.}}{\text{Correct recog.} + \text{Incorrect recog.}} \times 100$$

which he has used extensively in his work on recognition memory of advertisements. Myers has also employed Strong's formula. In explaining his formula Strong writes: "There are three factors which must be taken into account in obtaining a fair summary. There is first the number of advertisements that are correctly recognized—relationship between the number recognized and the total number that should be recognized. There is second the accuracy of the recognitions—the relationship between the number of correct and the number of incorrect recognitions. And there is third the general scheme of the experiment. In this experiment the subject had to select from an equal number of right and wrong advertisements. . . . Turning now to the first factor we see at once that by reducing the total number recognized to per cent. of all that should have been seen we can compare directly the results from, say, a series of 5 advertisements with results from other series. Such comparison is expressed by the formula

$$\frac{\text{Correct recognitions}}{\text{Total number presented}}$$

In presenting the second factor we must recognize that when there is an equal chance of selecting a right or wrong advertisement (when an equal number of each are presented as in this experiment) a record of 50 per cent. correct recognitions means nothing but pure chance. This 50 per cent. recognition really means nothing else than *zero memory* for although the subject has picked out  $x$  advertisements correctly from the  $n$  advertisements presented originally yet he has picked out an equal number incorrectly from those advertisements which had not been presented to him. . . . *Perfect memory*, on the other hand, would be, of course, where the  $n$  advertisements presented were all recognized and none of the wrong advertisements

were selected. The following formula,

$$\frac{\text{Correct recognitions} - \text{Incorrect recognitions}}{\text{Correct recognitions} + \text{Incorrect recognitions}}$$

will give 100 under these conditions corresponding to perfect memory as defined above, 0 under those conditions corresponding to zero memory as defined above, and equal steps between the two extremes as the factors vary successively.

“By combining the two formulæ and multiplying the results by 100 to have it read in terms of per cent. instead of a decimal we have

$$\frac{\text{Correct recognitions}}{\text{Total number presented}}$$

$$\times \frac{\text{Correct recognitions} - \text{Incorrect recognitions}}{\text{Correct recognitions} + \text{Incorrect recognitions}} \times 100$$

This formula combines the per cent. of correct recognitions among the possible recognitions with the accuracy of the recognitions.”

Woodworth has suggested a simple scoring method for recognition: Total number—two times errors—omissions=Recognition score. He writes: “The subject’s score should be a measure of the memory factor in determining his reactions and is found according to the following principles: evidently the cases where the subject says ‘I don’t remember’ give no evidence of the memory factor. The cases where he says, ‘It was shown before’ or ‘It was not shown before’ (YES or NO), on the other hand, purport to represent the subject’s memory and if they contain no errors they can be accepted as due wholly to memory and their number as giving a measure of memory. But if there are errors the number of YESes and NOS can not be accepted at full value. Nor can the number of correct YESes and NOS be taken as the measure since the presence of errors shows that something like guessing came in. Now, under the conditions of this experiment a guess is equally likely to turn out right as wrong and accordingly we assume that as many are found among correct answers as among the incorrect and find the number of guesses by taking twice the number of errors. Adding twice the number of errors to the ‘Don’t remember’ cases we obtain the total number of cases in which no memory is in evidence and subtracting this from the whole number of answers, or 50, we obtain the subject’s score.

“A rather better defence of the above method of scoring would substitute for the word guess some such expression as ‘tendencies to react that are not derived from memory of the presentation.’ There may be present in the subject numerous tendencies leading

towards an answer YES or NO but all these tendencies can be divided into two classes. Those derived from the presentation or from the 25 stimuli originally shown and those derived from other sources. The tendencies of the first class tend always toward right answers, while those of the second class tend equally toward right and wrong answers. Any given reaction may be the resultant of both sorts of tendencies, but in the long run the effect of the tendencies of the second class must show itself by producing an equal number of right and wrong answers and therefore a measure of these tendencies can be obtained by taking twice the number of errors. This procedure, like all others found on probability, may do violence to the fact in the single case but comes out right in the total."

The formula  $\cos \pi U$  may also be employed to determine the score for recognition.

Strong's scores are presented, on a per cent. basis, a perfect score being represented by 100 and the lowest score by 0. For Woodworth the scores run theoretically from the total number of possible recognitions to 0. With the  $\cos \pi U$  formula the scores run from 100 to 0. Thus all give similar scores for "all right" and "all wrong." The following examples will illustrate the differences in scoring.

## EXAMPLE I

## TOTAL NUMBER OF ITEMS IN RECOGNITION SERIES 10

Total Number of Recog.	Correct Recog.	Incorrect Recog.	Strong's Score	Step	Wood- worth's Score	Step	$\cos \pi U$	Step
10	10	0	100	28	10	2	1.0000	.0490
10	9	1	72	24	8	2	.9510	.1421
10	8	2	48	20	6	2	.8089	.2212
10	7	3	28	16	4	2	.5877	.2788
10	6	4	12	12	2	2	.3089	.3089
10	5	5	0		0		.0000	

Strong's penalties decrease as the number of wrong recognitions increases, the penalties in the  $\cos \pi U$  formula increase as the number of wrong recognitions increases, while Woodworth's penalties remain the same. Thus when 50 items are given, suppose  $X$  gets 45 right and 5 wrong and  $Y$  has 46 right and 4 wrong, the difference between  $X$ 's and  $Y$ 's scores is 5.3, but if  $M$  gets 35 right, 15 wrong and  $N$  34 right and 16 wrong the difference in their score is 3.5. According to Woodworth's formula  $X$ 's score is 40,  $Y$ 's 42,  $M$ 's 20,  $N$ 's 18; the difference in  $X$ 's and  $Y$ 's score is the same as the difference between  $M$ 's and  $N$ 's scores, 2.

Strong's formula is based on the argument that to recognize one more after having recognized 45 correctly is more difficult than one

## EXAMPLE II

Total Number Recog.	Correct Recog.	Incorrect Recog.	Strong's Score	Step	Woodworth's Score	Step	$\cos \pi U$	Step
50	50	0	100.0	5.9	50	2	1.0000	.0018
	49	1	94.1	5.8	48	2	.9982	.0058
	48	2	88.3	5.4	46	2	.9924	.0098
	47	3	82.7	5.4	44	2	.9826	.0138
	46	4	77.3	5.3	42	2	.9688	.0178
	45	5	72.0	5.1	40	2	.9510	.0215
	44	6	66.9	5.0	38	2	.9295	.0251
	43	7	61.9	4.8	36	2	.9044	.0287
	42	8	57.1	4.6	34	2	.8757	.0318
	41	9	52.5	4.5	32	2	.8439	.0350
	40	10	48.0	4.3	30	2	.8089	.0382
	39	11	43.7	4.1	28	2	.7707	.0414
	38	12	39.6	4.1	26	2	.7293	.0445
	37	13	35.5	3.9	24	2	.6848	.0473
	36	14	31.6	3.6	22	2	.6375	.0498
	35	15	28.0	3.5	20	2	.5877	.0419
	34	16	24.5	3.4	18	2	.5358	.0539
	33	17	21.1	3.2	16	2	.4819	.0559
	32	18	17.9	3.0	14	2	.4260	.0578
	31	19	14.9	2.9	12	2	.3682	.0593
	30	20	12.9	2.7	10	2	.3089	.0604
	29	21	9.3	2.6	8	2	.2485	.0612
	28	22	6.7	2.4	6	2	.1873	.0620
	27	23	4.3	2.1	4	2	.1253	.0625
	24	24	2.1	2.1	2	2	.0628	.0628
	25	25	0		0		.0000	

more after 15. The argument may be right, but Strong is not convincing in showing why the step should be 5.9 between perfect score and score of one wrong when 50 items are in the series, 3.5 between 15 wrong and 16 wrong when 50 items are in the series, 28 between perfect score and one wrong when there are 10 items in the series.

For purposes of comparing recall and recognition the formula for recognition more nearly comparable with that used for recall is that of Woodworth. To employ Strong's formula or the  $\cos \pi U$  formula would necessitate an empirical formula for recall. The chances of a guess in recall are not nearly so great, but the question as to the greater difficulty of recalling one more after having recalled 10 arises. The results of Strong's formula for recognition are not sufficiently convincing of its worth to warrant an attempt to devise an empirical formula for recall.

The scoring "Total Correct" will be used throughout the following chapters for recall. For recognition the score will be "Total number—twice number of errors—omissions (if there are any)."



The possible criticism for each and the full meaning of the figures must not be forgotten.

The coefficients of correlation in the following chapters were obtained by the statistical method explained by Woodworth in the *Psychological Review*, March, 1912, Vol. XVI., pages 97-123.

### 3. *Groups Tested and Procedure*

Two groups of adults were tested, in one there were twenty-eight women, twenty-four men; in the other twenty-four women and twenty men, making ninety-six persons.

The material was presented in the following order: (Set *A*) words, geometrical forms, proverbs, nonsense syllables, words; (Set *B*) words, geometrical forms, proverbs, nonsense syllables, words. To the subjects in the group of fifty-two adults a test for recall memory was made after each of the last five series (Set *B*). The tests were given separately for each subject. Each subject was given the following written directions:

You will be shown different kinds of material and afterwards an attempt will be made to determine how much you have remembered. The material will vary—there will be series of words, of forms, of proverbs, and of syllables. The series will always be the same length—25 items. Your memory will be tested by different methods—sometimes by asking you to write down what you remember, and sometimes by showing you the material again mixed with other items which have not been seen and requesting you to state which you had seen and which you had not seen.

The time given to read the presented series will always be the same—50 seconds. In order that you may have some idea how long that is, before the experiment begins a picture will be shown for 50 seconds.

Teachers, business men, students, housekeepers, etc., were among the subjects, most of them were undergraduate or graduate students in Columbia University.

Tests for recall of words, recall of forms, recall of syllables, recognition of words, recognition of forms, recognition of syllables were made on six hundred thirty-eight children, two hundred eighty-five boys and three hundred fifty-three girls in a large city public school. The children were in twenty-two classes in the ten grades *4A*, *4B*, *5A*, *5B*, *6A*, *6B*, *7A*, *7B*, *8A*, *8B*. Each class was tested as a group; the classes were mixed so that the boys and girls were tested under the same conditions. The following table shows the number of girls and boys in each grade.

	Girls	Boys
4A .....	50	41
4B .....	39	29
5A .....	47	39
5B .....	30	41
6A .....	36	26
6B .....	37	22
7A .....	11	25
7B .....	31	22
8A .....	34	21
8B .....	38	19
	<hr style="width: 100%; border: 0.5px solid black;"/> 353	<hr style="width: 100%; border: 0.5px solid black;"/> 285

The following directions were given orally to each group tested:

I am going to show you some things and afterwards find out how much you can remember. Sometimes I shall show you words, sometimes forms, such as circle or a square, and sometimes nonsense syllables—nonsense syllables always have three letters put together in such a way that they do *not* make sense. Sometimes I shall find out how much you can remember by asking you to write down afterwards how many you remember and sometimes by showing you them again mixed with some that you have not seen before. There will always be 25 things to study and you will always be given 50 seconds in which to study them. In order that you may have some idea how long that time is I shall show you a picture for 50 seconds before we begin.

It was desired to give the children some idea of how long the period of fifty seconds is. To have timed empty space would have caused an illusion of time to enter. The gazing at a picture served also to get the children's attention and interest. To keep the conditions the same for adults a picture was shown to them too. Each subject had his or her material so that any advantage or disadvantage due to his or her position in the room might be avoided. The materials were kept in different colored envelopes.

Nineteen insane persons were tested each separately. The results of these subjects will be considered in Chapter VI.

## CHAPTER V<sup>1</sup>

### RELATION BETWEEN MEMORY PROCESSES; RECALL AND RECOGNITION

#### 1. Comparison of Different Series of the Same Material

(See charts on following pages)

It has been stated in the preceding chapter that there are two sets of material. Set *A* and Set *B* complete each contain a series of twenty-five words, twenty-five forms, twenty-five proverbs, twenty-five syllables and a second series of twenty-five words. In every case

TABLE XII

SET A					
	Recall Words	Recall Forms	Recall Proverbs	Recall Syllables	Recall Words
52 Subjects					
Average .....	9.23	6.17	5.52	3.44	11.54
A.D. ....	2.80	2.26	1.39	1.09	3.31
P.E. ....	.33	.27	.16	.13	.39
SET B					
44 Subjects					
Average .....	8.27	6.77	5.52	2.73	9.59
A.D. ....	2.41	2.02	1.64	1.67	2.66
P.E. ....	.31	.26	.21	.21	.34
SET B					
	Recog. Words	Recog. Forms	Recog. Proverbs	Recog. Syllables	Recog. Words
52 Subjects					
Average .....	32.52	13.52	33.12	18.65	33.46
A.D. ....	8.79	5.21	6.72	6.56	8.18
P.E. ....	1.03	.61	.79	.77	.96
SET A					
44 Subjects					
Average .....	29.68	25.54	34.14	23.82	33.59
A.D. ....	7.30	6.68	6.47	6.64	6.97
P.E. ....	.93	.85	.82	.85	.89

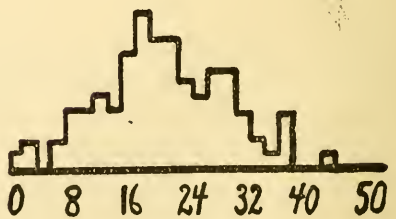
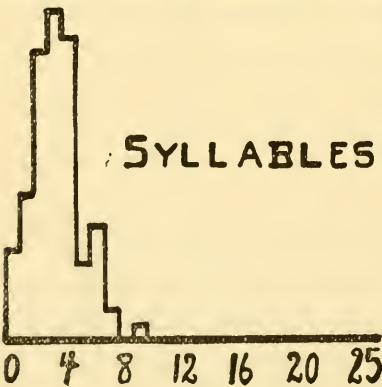
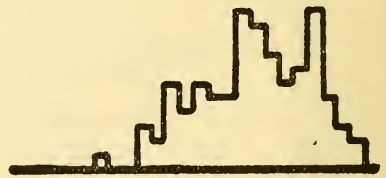
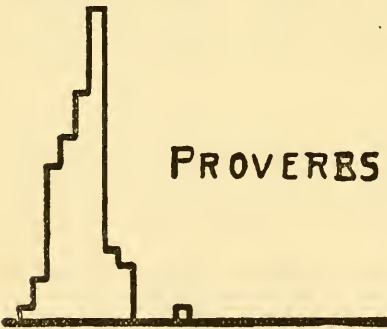
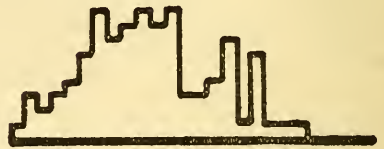
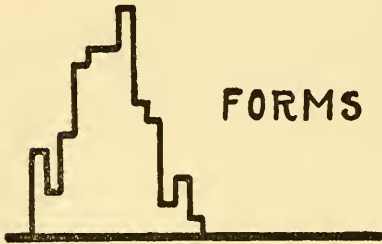
Set *A* was presented to the subject first and Set *B* second. For the group of fifty-two adults the test for recall was made for Set *A*, for recognition for Set *B*. In the group of forty-four adults the recognition test was made for Set *A* and the recall test for Set *B*.

<sup>1</sup>Some of the data in this chapter have been published by the author in "Tests of the Memories of School Children," Edith F. Mulhall, *Journal of Educational Psychology*, May, 1917.

Recall

96 ADULTS

Recog.



0 4 8 12 16 20 25

0 8 16 24 32 40 50

The materials in Set *A* were recognized by forty-four adults and recalled by fifty-two adults. The materials in Set *B* were recalled by forty-four adults and recognized by fifty-two adults. Thus one group recalled the material which the other group recognized. In this way, one might see whether the series in the two sets were about equally difficult. Table XII. shows the average, the average deviation, and the P.E. of the average for these groups.

The different series of the same material appear to be about equally difficult. In each case, except for the recognition of forms, the difference between the scores is small and the deviation fairly large. More words in Set *A* were recalled by the group of fifty-two than in Set *B* by the group of forty-four. The average score of the second series of words is slightly higher in both recall and recognition for both groups. The forms in each set seem to be equally difficult to reproduce, but those in Set *A* harder to recognize. This is probably due to the control figures being more confusing and more like the presentation series in Set *A* than the control figures in Set *B* are like the presentation figures in Set *B*.

The scores for recall for the two groups have been combined and the scores for recognition for the two groups have been combined giving the following results for ninety-six subjects.

	Words	Forms	Proverbs	Syllables	Words
Recall .....	8.75	6.47	5.55	3.09	10.57
Recog. ....	31.10	...	33.63	21.24	33.53

## 2. *Recalling and Recognizing of the Same Material*

The complex question concerning the relation between the results obtained by testing memory by recall and by recognition is reduced to several simple ones which are stated in Chapter II.

The first inquires about the relation between the recalling and recognizing of the same material. Does the person who recalls one kind of material well also recognize that kind of material well?

The coefficients of correlation between recall of words and recognition of words, between the recall of forms and the recognition of forms, between the recall of proverbs and the recognition of proverbs, between the recall of syllables and the recognition of syllables, were calculated for the two groups of adults. The coefficients of correlation between the recall of words and the recognition of words, between the recall of forms and the recognition of forms, and between the recall of syllables and the recognition of syllables by the children were computed for each grade. Table XIII. gives these coefficients of correlation.



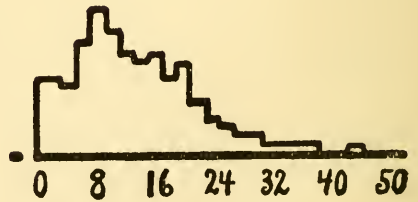
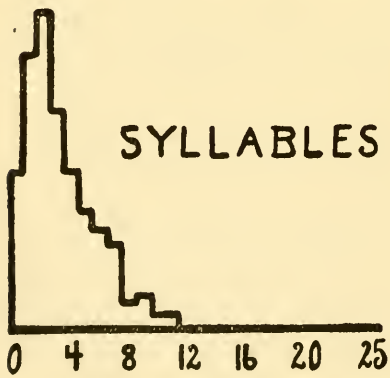
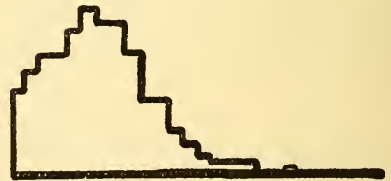
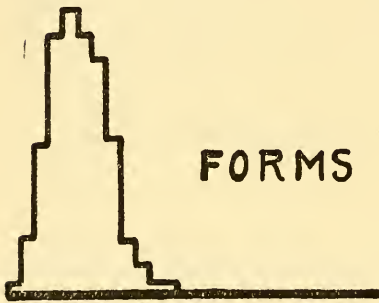
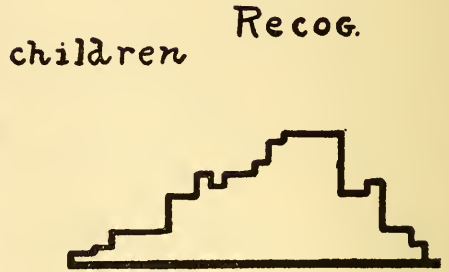
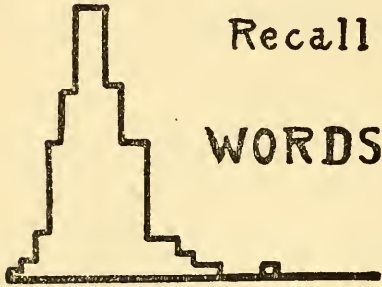


TABLE XIII

Adults		Rc. Set A	Rg. Set B	Rg. Set A	Rc. Set B
Recall Words	Recog. Words	.24	—	.18	—
Recall Forms	Recog. Forms	—	.18	—	.16
Recall Proverbs	Recog. Proverbs	.42	—	.08	—
Recall Syllables	Recog. Syllables	.32	—	.74	—
Recall Words	Recog. Words	.24	—	.34	—
Average		.21	—	.25	—
Recall Words	Recog. Words, corrected by attenuation	.75	—	.52	—

Children		4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	Av.
Recall Words	Recog. Words	.12	.18	.38	.52	.23	.06	.10	.22	.44	.44	.25
Recall Forms	Recog. Forms	.34	.28	.00	.06	.42	—	.16	.32	.12	.22	.34
Recall Syl.	Recog. Syl.	.34	.18	.34	.00	.22	.14	.12	.16	.06	.06	.17

If the coefficients had been near  $-1.00$  it would have indicated that those who recalled well recognized poorly and if the coefficients had been  $1.00$  it would have indicated that those who recalled well recognized well. The coefficients are low; the average (without correcting for attenuations) for the adult group being  $.23$ , for children  $.21$  with a large P.E. Coefficients corrected for attenuation are higher. Before drawing any conclusions from these data, an examination of the following tables may be made.



RECALL FORMS

Recognition Forms	11	10	9	8	7	6	5	4	3	2	1	0
38 .....						1					1	0
32 .....					1			1				
30 .....					1	1	1					
28 .....					1		3				1	
26 .....					2	3		1				
24 .....				1	2	2	2	2	2	1	2	
22 .....			2	2	5	2	2	2	5	1		
20 .....			2		2	1	5	6	6	5		
18 .....			1		5	9	7	8	1	4		
16 .....				4	9	10	14	10	4	5		
14 .....			2	3	8	8	9	13	5	6	5	
12 .....		1		5	5	9	10	10	11	7	4	
10 .....	1	1		2	8	14	12	7	14	12	1	
8 .....			2	3	5	8	8	9	12	4	5	
6 .....		1	2	1	3	7	9	9	12	2	1	
4 .....				1	2	5	7	11	10	9	1	1
2 .....					4	6	11	12	8	5	3	
0 .....			1			4	1	10	5	1		1
— 2 .....			1	1	1		3	2	5	2		1
— 4 .....						1	5	2	2			
— 6 .....						1	1	3		2		
— 8 .....						1		2	4	1		
— 10 .....							1					

Recognized Syllables	RECALL SYLLABLES									
	9	8	7	6	5	4	3	2	1	0
44 .....										1
42 .....										
40 .....		1					1			
38 .....					1			1		
36 .....								1		
34 .....								1		1
32 .....			1				1	1	1	
30 .....					1	1		4	3	
28 .....							1		1	
26 .....						2	4	3	1	
24 .....			2		1	3	4	3	3	
22 .....			1	4		2	5	5	6	3
20 .....			2	1		9	7	10	7	2
18 .....					3		8	10	5	6
16 .....					4	4	13	10	11	1
14 .....						7	3	10	10	8
12 .....				1	2	4	12	9	9	7
10 .....	1		1		3	7	5	21	10	6
8 .....			1	1	2	7	8	20	14	12
6 .....				1	1	3	7	14	16	7
4 .....						2	2	11	9	6
2 .....	1			1		4	5	7	7	5
0 .....						1	3	10	8	12
— 2 .....			1		1	1	2	7	7	2
— 4 .....						1	1	5	2	2
— 6 .....								2	1	1
— 8 .....						1				1
— 10 .....										
— 12 .....									1	

Along the horizontal line are represented the scores for recall, along the vertical are the scores for recognition. The numbers in the diagram represent the number of children who had the different score, thus four persons with the score of 5 for recall of words had the score of 48 for recognition, two persons with the recall score of 5 had recognition score for words of 46.

The tables show the recall and recognition scores for all the children. If the correlation between recall and recognition were great—*i.e.*, if the children who recalled well recognized well, most of the cases would lie along the diagonal from the upper left side to the lower right side, and if there is a negative correlation, most of the cases would lie along the other diagonal, from upper right side to lower left side. Neither of these situations occurs in any cases—there is no high positive nor negative correlation. In the recall of words twenty children have a score of over eleven and in recognition thirty-



five had a score of forty-two or over, but only one of the twenty is in the group of thirty-five. The best scores for recall are 17, 15, 15, 14 and the recognition scores for these subjects are respectively 24, 34, 34, 40. The best scores for recognition are 50, 48, 48, 48, 48, 48, 48, 48, 48, and the recall scores for the subjects having these scores or respectively 9, 13, 9, 9, 7, 6, 5, 5, 5, 5, 3. The seven worst scores for recall are all one (1) and the recognition scores of these subjects 44, 40, 24, 16, 14, 6, 2. In the test for forms four children had a recall score of 10 or over and six a recognition score of 30 or over. None of the four is among the six. The best scores for recall are 11, 10, 10, 10, and the subjects with these recall scores had the following scores for recognition, 10, 12, 10, 8 respectively. The best scores for recognition of forms are 38, 32, 32, 30, 30, 30 and the recall scores of the same subjects are respectively 6, 7, 4, 7, 6, 5. The three subjects with zero scores for recall of forms were among the 113 subjects who had 4 or less for their recognition scores.

In the test for syllables three children have the recall scores 8, 9, 9; their recognition scores are 40, 10, 2 respectively. The three best recognition scores are 40, 40, 44 and the recall scores of the same subjects 8, 3, 0, respectively. Those with recognition scores below 4 have recall scores ranging from 9 to 0; recall scores of zero have high and low recognition scores.

From the coefficients of correlation and from the tables one finds no very high negative nor positive correlation. These data would indicate that a person who recalls a certain material well may recognize that kind well, fairly well, or poorly—we know little about one's recognition memory from a test of recall. There is a strong tendency, in general, for the correlation to be positive rather than negative. The grade-groups of children on the average do not differ from the groups of adults in degree of correlation any more than the different grade-groups of children differ among themselves. There is no marked increase in degree of correlation from grade to grade. Except for the low correlation among adults for forms, there is no consistent difference in degree of correlation between recall and recognition material.

### 3. *Recall of Different Materials*

Earlier investigators have shown that those who recall one kind of material well may not recall another kind well. The present results may be examined for a confirmation or contradiction of their conclusion. The coefficients of correlation between the recall of words and recall of forms, between the recall of words and the recall of

proverbs, between the recall of words and the recall of syllables, between the recall of forms and the recall of proverbs, between the recall of forms and the recall of syllables, between the recall of proverbs and the recall of syllables for both groups of adults and the coefficients of correlation between the recall of words and recall of forms, between the recall of words and syllables and between the recall of forms and syllables for each of the ten grades of school children are given in Table XV.

TABLE XV

GROUP OF 52 ADULTS—CORRELATION BETWEEN THE RECALL OF DIFFERENT MATERIALS IN SET A

	Words	Forms	Proverbs	Syllables	Words
Words .....		.84	.52	.48	.38
Forms .....	.84		.12	-.02	
Proverbs .....	.52	.12		.12	
Syllables .....	.48	-.02	.12		
Words .....	.38				

GROUP OF 44 ADULTS—CORRELATION BETWEEN THE RECALL OF DIFFERENT MATERIALS IN SET B

	Words	Forms	Proverbs	Syllables	Words
Words .....		.16	.18	.16	.52
Forms .....	.16		-.12	-.04	
Proverbs .....	.18	-.12		-.04	
Syllables .....	.16	-.04	-.04		
Words .....	.52				

GROUP OF 638 SCHOOL CHILDREN—CORRELATION BETWEEN RECALL OF DIFFERENT MATERIALS

Number in each grade .....	91	68	86	71	62	59	36	53	55	57
Grade .....	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B
Re Words ....}	-.06	-.10	-.04	.18	-.10	.04	-.28	.42	-.06	.32
Re. Forms....}										
Re. Words....}	.18	-.02	.16	.28	.18	.30	.00	.24		.12
Re. Syl. ....}										
Re. Forms....}	.12	-.08	-.12	-.10	.22	.18	.10	.10		.44
Re. Syl. ....}										

The coefficients average about zero. The data confirm the results of previous investigations that a person who recalls one material well may not recall another material well. This appears to be true for children and for adults.

The coefficients vary, but there is a tendency for them to be positive rather than negative. Five of the six coefficients between the recall of different materials in Set A are positive and the total of the positive coefficients is 1.84 and of the negative .02. Three of the six

coefficients for recall between different materials in Set *B* are positive and the total of positive coefficients is .52 and the negative .28. Eighteen of the twenty-eight coefficients among the groups of children for recall of different materials are positive; the total of positive coefficients is 3.58 and negative .96.

The coefficients of correlation for recall of words with other materials average for Set *A* .61, for Set *B* .13; the coefficients of correlation for recall of forms with recall of other material is for Set *A* .31, for Set *B* .01; the coefficients for recall of proverbs with the recall of the other materials for Set *A* .25, for Set *B* .01; the coefficients for recall of syllables with recall of other materials is for Set *A* .19, for Set *B* .03. The average of the coefficients of recall of words with recall of forms and recall of syllables among children is .095, recall of forms with recall of words and recall of syllables is .07, recall of syllables with recall of words and recall of forms .12.

There is little difference in materials—the coefficients for all are low and the P.E. large, with the exception of recall of words with recall of other materials in Set *A* by the adults. From the results among the adults it might appear that words are a better index of one's recall memory than the other materials, but the children's records do not indicate this.

#### 4. *Recognition of Different Materials*

Does the person who recognizes one material well recognize another well?

The coefficients of correlation between recognition of different materials for both groups of adults and for each grade of school children are given in Table XVI.

The average of the coefficients of correlation between the recognition of different materials in Set *A* is .37 and for Set *B* .28. The average of the coefficients of the grade-groups of children is .18.

The coefficients vary, but there is a tendency for them to be positive rather than negative. Five of the six coefficients between recall of the different materials in Set *A* and in Set *B* are positive. In Set *A* the total of the positive coefficients is 2.26, the negative .04; in Set *B* the total of the positive is .78, negative .12. Twenty-three of the twenty-eight coefficients of correlation between recognition of different materials are positive; the total of the positive coefficients is 5.32 and the negative .16.

The average of the coefficients of correlation for recognition of words with other material in Set *A* is .33, in Set *B* .42; for recognition of forms with other material in Set *A* .25, in Set *B* .15; for rec-

ognition of proverbs with other material in Set A .39, in Set B .44; for recognition of syllables with other material in Set A .51, in Set B .39. The average of the coefficients for recall of words with recall of forms and recall of syllables among children is .20, for recall of forms with recall of words and recall of syllables is .17, for recall of syllables with recall of words and recall of forms is .17.

The correlation between recognition of different materials is low. The person who recognizes one material well may or may not recognize another material well. The correlation between recognition of different materials is about the same as the correlation between recall of different materials. Between recall of different materials the coefficients of correlation for the adult groups are .35 and .27 and between the recognition of different materials .37 and .28.

TABLE XVI

GROUP OF 52 ADULTS—COEFFICIENTS OF CORRELATION BETWEEN RECOGNITION OF DIFFERENT MATERIALS IN SET B

	Words	Forms	Proverbs	Syllables	Words
Words .....		-.04	.48	.54	.42
Forms .....	-.04		.24	.56	
Proverbs .....	.48	.24		.44	
Syllables .....	.54	.56	.44		
Words .....	.42				

GROUP OF 44 ADULTS—COEFFICIENTS OF CORRELATION BETWEEN RECOGNITION OF DIFFERENT MATERIALS IN SET A

	Words	Forms	Proverbs	Syllables	Words
Words .....		.32	.28	.66	.38
Forms .....	.32		-.12	.24	
Proverbs .....	.28	-.12		.28	
Syllables .....	.66	.24	.28		
Words .....	.38				

GROUP OF 638 CHILDREN—COEFFICIENTS OF CORRELATION BETWEEN RECOGNITION OF DIFFERENT MATERIALS

Grade	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	Av.
Rg. Words... } .52	-.04	.10	.32	.30	.14	-.04	.04	.42	.22	.20	
Rg. Forms... }											
Rg. Words... } .34	.06	-.02	.52	.04	.20	.04	.38		.28	.20	
Rg. Syl. .... }											
Rg. Forms... } .66	.04	.04	-.02	.28	-.04	.12	.22		.04	.15	
Rg. Syl. .... }											

5. Differences in Material

Are some materials more easily recalled than others? Are some more easily recognized? Are those recalled well also recognized?

From Table XII. it is seen that the material with the best score



for recall is words, then forms and proverbs, and the worst score is for syllables, for both groups of adults. For recognition the order of the scores from highest to lowest is proverbs, words, forms and syllables, and is the same for both groups. Syllables are the hardest material to recall and to recognize. Words are recalled well and also recognized well, but proverbs are the easiest recognized.

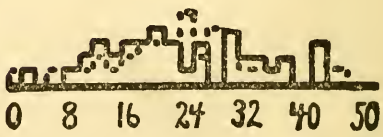
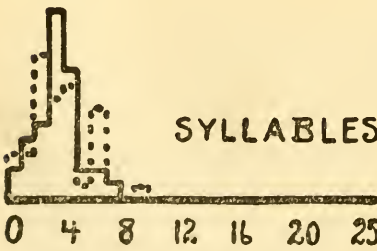
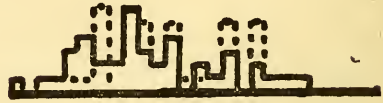
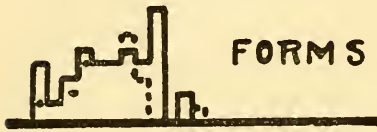
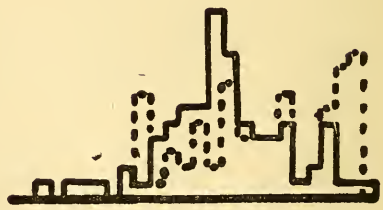
Some of the adults tested were asked to give their introspections. These show that for all the materials the subjects tried to associate the items, sometimes one item with another and sometimes with an experience outside of the presented series. Many of the subjects visualized the items or tried to remember the sound of them. Recency, primacy, familiarity, likes and dislikes all served as aids. The introspective accounts are similar for the different materials, and for recall and recognition, but different among different subjects.

The degree to which the method or means of remembering is successful depends upon the material—it is more difficult to form associations for syllables than for words. It appears that the material with the greatest number of associations is best remembered. In the tests for words one can form associations with other words or with outside experiences, visualize, or imagine the sound; the word can be remembered as a single item, not each letter separately. In some cases, the forms might be named but often by a phrase rather than a word, they could be visualized, but few associations, either between them or with outside experiences can be made, and often separate lines in the form have to be remembered instead of the form as a single item. The proverbs are familiar material, but are remembered for their "idea" more than word for word and hence are easily recognized but not so easy to recall. The syllables have the fewest associations and are most difficult to recall or recognize.

#### 6. *Sex Differences in Achievement*

In examining sex differences every attempt was made to exclude other factors, or to keep them constant, which might influence the scores. It has been suggested that in many experiments on sex differences unequal numbers of each sex have been subjects and comparisons might be fairer if the same number of each sex were tested. Equal numbers of men and women are, therefore, in each of the adult groups compared. They were selected at random from the subjects which were graduate and undergraduate students in Columbia University. There are not equal numbers of boys and of girls in the grade-groups of children. To have taken equal numbers of boys and of girls in each grade would have reduced the number of subjects in





0 4 8 12 16 20 25

0 8 16 24 32 40 50

— MEN

... WOMEN

each grade. The number of girls and of boys in each grade may be seen by referring to Table XV. on page 42.

TABLE XVII

## SEX DIFFERENCE IN RECALL AND RECOGNITION

*Group of 20 Women—Recognition Set A, Recall B*

See chart on opposite page.

	Words	Recall				Recognition				
		Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Total ...	180	132	123	53	208	660	536	683	493	732
Av. ....	9.00	6.60	6.15	2.65	10.40	33.00	26.80	34.15	24.65	36.60
M.V. ....	2.30	1.99	1.45	1.74	2.61	8.30	5.39	6.28	6.65	7.14
P.E. ....	.44	.37	.27	.33	.50	1.37	1.02	1.18	.26	1.35
Range ...	4-19	3-13	2-9	0-7	5-20	18-48	16-34	12-48	0-38	22-48

*Group of 20 Men—Recognition Set A, Recall Set B*

	Words	Recall				Recognition				
		Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Total ...	150	129	102	61	176	550	493	684	467	616
Av. ....	7.50	6.46	5.10	3.05	8.80	27.50	24.65	34.20	23.35	30.80
M.V. ...	2.25	2.05	1.07	1.32	2.29	4.25	7.70	6.45	6.78	6.28
P.E. ....	.43	.39	.32	.27	.43	.80	1.46	1.22	1.28	1.19
Range ...	3-15	2-10	1-4	0-7	5-17	10-44	6-40	22-42	8-38	16-50

TABLE XVIII

*Group of 20 Women—Recall Set A, Recognition Set B*

	Words	Recall				Recognition				
		Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Total ...	217	137	122	80	274	712	295	675	406	738
Av. ....	10.35	6.85	6.10	4.00	13.70	35.60	14.75	33.75	20.30	36.90
M.V. ...	3.33	1.95	1.34	1.20	2.81	9.74	5.05	6.35	8.08	7.01
P.E. ....	.64	.37	.25	.23	.53	1.84	.95	1.20	1.51	1.33
Range ...	4-18	4-12	4-9	2-9	8-20	17-48	4-24	22-44	6-44	24-48

*Group of 20 Men—Recall Set A, Recognition Set B*

	Words	Recall				Recognition				
		Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Total ...	158	149	98	65	204	589	258	642	340	598
Av. ....	7.90	7.45	4.90	3.25	10.20	29.45	12.90	32.10	17.00	29.90
M.V. ...	2.41	2.36	1.41	.83	2.94	7.50	5.10	6.10	5.60	7.94
P.E. ....	.46	.45	.25	.16	.56	1.42	.96	1.20	1.59	1.50
Range ...	3-14	2-12	3-7	1-6	3-16	12-48	0-26	22-48	2-32	22-40

The scores of the boys and of the girls are given in the following table.

TABLE XIX

	Recall Words						Recognition Words					
	Boys			Girls			Boys			Girls		
	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.
4A	4.12	1.36	.18	4.30	1.41	.17	20.15	8.92	1.18	23.36	8.14	.97
4B	4.41	1.29	.20	5.33	1.73	.23	14.79	8.64	1.35	23.32	9.91	1.34
5A	5.18	1.58	.21	5.64	1.75	.22	23.74	9.17	1.24	28.19	9.31	1.15
5B	5.66	1.44	.19	5.60	1.54	.24	23.88	8.94	1.18	26.73	7.64	1.18
6A	5.69	1.82	.30	6.08	1.87	.26	29.38	9.58	1.27	28.22	9.86	1.39
6B	6.36	1.28	.23	6.49	1.39	.19	24.25	8.05	1.45	35.04	7.80	1.05
7A	6.48	2.02	.34	7.36	1.67	.42	27.12	8.46	1.43	32.73	7.25	1.87
7B	8.18	1.88	.34	7.45	2.12	.32	24.04	6.15	1.11	31.81	8.86	1.34
8A	6.86	1.56	.29	8.09	1.95	.28	29.62	7.01	1.29	28.94	9.89	1.43
8B	6.63	1.55	.35	7.76	1.81	.30	27.68	9.84	1.91	32.39	6.94	.95
	Recall Forms						Recognition Forms					
	Boys			Girls			Boys			Girls		
	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.
4A	3.32	1.30	.17	4.30	1.41	.19	7.56	6.28	.83	8.16	5.98	.71
4B	3.69	1.49	.23	3.33	1.09	.15	8.10	6.59	1.03	5.36	6.20	.83
5A	4.26	1.47	.20	4.15	1.28	.16	11.15	6.02	.81	9.21	5.47	.67
5B	4.59	1.61	.21	4.00	1.30	.21	9.73	6.19	.82	8.23	4.73	.83
6A	4.42	1.46	.24	4.95	1.40	.20	11.88	4.98	.83	13.47	6.73	.95
6B	5.27	1.55	.22	5.22	1.58	.22	10.36	6.29	1.13	14.92	5.64	.78
7A	5.08	.85	.14	4.55	1.80	.46	8.36	3.43	.58	8.09	4.26	1.09
7B	6.23	1.29	.21	5.77	1.67	.25	9.77	5.16	.93	10.48	5.50	.83
8A	5.43	1.33	.24	5.38	1.57	.23	12.14	6.63	1.01	11.71	6.71	.97
8B	5.63	1.18	.23	5.24	1.50	.21	14.61	5.89	1.14	11.48	6.34	.87
	Recall Syllables						Recognition Syllables					
	Boys			Girls			Boys			Girls		
	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.	Av.	M.V.	P.E.
4A	1.54	.94	.12	2.00	1.24	.15	6.95	6.10	.81	8.62	7.12	.85
4B	1.51	.71	.11	1.82	1.09	.15	2.45	6.19	.97	10.26	6.57	.89
5A	1.74	1.43	.19	1.83	1.17	.14	7.34	6.21	.84	10.68	6.29	.78
5B	2.87	1.39	.18	2.10	1.13	.17	9.98	7.39	.98	9.60	6.99	10.08
6A	1.81	.76	.17	2.41	1.34	.19	15.81	6.45	1.07	15.83	6.44	11.16
6B	1.86	.93	.17	2.21	1.13	.16	11.41	4.90	.88	13.19	6.33	1.88
7A	2.24	.60	.10	2.64	1.03	.26	11.24	6.87	1.16	12.55	6.96	1.77
7B	3.00	1.18	.23	2.55	1.34	.22	10.32	6.17	1.11	14.06	8.33	1.26
8B	2.84	1.22	.24	5.37	2.70	.37	10.79	7.04	1.36	16.71	7.12	.98

For the recall records the men's scores are 7.50, 8.80, 7.90, 10.20 and the women's 9.00, 10.40, 10.35, 13.70. The women appear to recall words better than the men. For the recognition of words the men's scores are 27.50, 30.80, 29.45, 29.90 and the women's 33.00, 36.60, 35.60, 36.90, the scores of the women are higher. In the tests for recall of forms the average scores for the men are 6.45, 7.45, and

for the women 6.60, and 6.85; for recognition the men's average scores are 24.65 and 12.90 and the women's 26.80 and 14.75. For recall of forms men in one group on the average are superior and women in the other group, for recognition of forms women in both groups are superior. The men's average scores for recall of proverbs are 5.10 and 4.90 and the women's 6.15 and 6.10; for recognition of proverbs, men 34.20, 32.10, women 34.15, 33.75—a superiority for recall of proverbs among women but little difference for recognition. In the tests for recall of syllables men's average score are 1.32 and 3.25 and the women's 1.74 and 4.00; for recognition of syllables for men 23.35 and 17.00, for women 24.65 and 20.30.

Among the adults tested the women appear to be superior to the men, on the average. The tendency for the women's scores to be higher is greatest in the scores for recall and recognition of words and in the recall of proverbs. The P.E. of each average is given in the table.

In the table for children, girls are superior to boys six times out of ten for the recall of words. If one averages the averages, boys have 5.96 and the girls 6.41 or there is a difference of .45 in favor of the girls. Girls are superior to boys eight out of ten times for recognition of words, and the average of the averages for boys is 24.49 and for girls 29.07 or a difference in favor of the girls of 4.58. For recall of forms, girls are superior to boys two times out of ten and averaging the average, boys 4.79, girls 4.69, the boys are superior by .10. For recognition of forms girls are superior four times out of ten and averaging the averages, boys 10.37, girls 10.11, the boys are superior by .26. Girls are superior to boys seven times out of nine for recall of syllables and averaging the averages, boys 2.09, girls 2.55, the girls are superior by .46. In the recognition of syllables girls are superior to boys eight times out of nine and in the average of the averages, boys 9.59, girls 12.61, girls are superior by 3.02. To summarize, in the twenty-nine recall tests girls are superior seventeen times and in the twenty-nine recognition tests girls are superior twelve times. Little or no sex difference is present for recall of forms. These data show a tendency for girls to be superior to boys in recall and in recognition of words and of syllables.

Other investigators have reported superiority of girls in recall memory. Chamberlain (6), however, did not find any confirmation of the statement in his results. Any difference between the sexes which exists in the data in the preceding tables is present for recall and recognition; the difference between the sexes varies with the material. No apparent sex difference seems to be present either in achievement in recall or in achievement in recognition.



Some investigators who find women superior to men offer as an explanation, that women remember more details. The following experiment was performed on twenty men and twenty women each separately to see if there was any sex difference in the number of details remembered.

To each subject a colored picture seven and three eighth inches by eight and a half inches (Kaffeebesuch, P. Philippi) was shown with the following printed instructions:

“You will be shown a picture for ten seconds. Look at it so that you will be able to describe it afterwards.”

After the subject had seen the picture for ten seconds, he was given thirty-six cards three by five inches on each of which was pasted a piece of a picture. Eighteen of the pieces were from the picture previously presented, almost all of the picture being included among the eighteen pieces. The other eighteen pieces were from another picture but one with somewhat similar setting. The subjects were asked to place each card in one of four piles—(1) Sure you have seen, (2) fairly sure you have seen, (3) fairly sure you have not seen, (4) sure you have not seen. In piles 1 and 2 are YES answers and in 3 and 4 are No answers. The number of right YESes among the women averages 11.35 and among the men 10.00. The women remembered on the average more than the men. The number of right Nos by women averages 14.80 and for men 14.60. There is practically no difference between the sexes in recognizing that a certain item has not been seen before, but the women are a little superior to the men in recognizing a thing which has been seen before.

TABLE XX

	Right YESes			Right Nos		
	Average	M.V.	P.E.	Average	M.V.	P.E.
Woman .....	11.35	2.14	.40	14.80	2.06	.39
Men .....	10.00	2.70	.51	14.60	2.32	.49

The subjects were also shown fifteen pictures taken from the *National Geographic Magazine*. They were about eight by five inches, each pasted on paper ten by eight inches. They were black and white or brown and white. The pictures were selected on the basis of there being another picture available similar to it. The original fifteen pictures were shown successively, one each two seconds. They were mixed with the fifteen other pictures and the subject asked to arrange them in four piles as described above. To be able to distinguish which of the two pictures was the one seen one would often have to remember details of the picture. For example, two



pictures were of monuments. It was not enough to remember "monument." There were two interiors of churches, two walls with Egyptian writing, two windmills, two bridges, two groups of people, etc. The average score of right responses in piles 1 and 2 is 12.30 for women and 12.60 for men; the range for women being 8 through 14 and for men 10 through 15. The average number of wrong responses in these piles for women is 1.35 and for men .70. The subjects were asked to introspect, telling why they choose each picture. Both the men and the women mentioned details. The following are a few of the ones given: (men) "Trend of the grass," "Little girl standing by river," "Side view of this bridge different," "Cloud effects," "Flag near top of this monument," "Light and dark trees"; (women) "Dark trees," "Grass, twigs," "Figures on base," "Sky," "Long aisle," "Sand dunes," "Telegraph pole in the back." The men and the women recognize about the same number of pictures correctly; the women incorrectly select more than the men, this point will be discussed in Chapter VII. The data do not suggest that women remember more details.

Women appear to remember more items than do the men in the memory tests, but there seems no evidence that this is because they remember more *details*.

### 7. Sex Difference in Variability

Are there any sex differences in variability among the adults or among the children in the recall of different materials? in the recognition of different materials?

In Table XXI. the average, the probable error of the average (P.E.), the Pearson Coefficient of Variability (P.C.) and the range are given for the two groups of men and for the two groups of women. The measure of variability known as the Pearson coefficient is the gross variability divided by the average.

Among the twenty Pearson coefficients seven are larger for the women. Eight of the twenty P.E. measures are higher for the women, two are equal for both sexes and ten are higher for men. The range indicates the lowest and the highest scores in the group. Among the twenty scores representing the poorest scores in the group for each test, two are lower for women than for men and three are the same for both men and women. Eleven of the twenty best scores in each group for each test are higher for women, in five cases the highest scores are the same for men and for women, and in four cases the men's best scores are higher than the women's best scores.

No sex difference in variability is apparent among the adult

TABLE XXI

## GROUP OF 20 WOMEN—RECOGNITION SET A, RECALL SET B

	Words	Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Av. ....	9.00	6.60	6.15	2.65	1.04	33.00	26.80	34.15	24.65	36.60
P.E. ....	.44	.37	.27	.33	.50	1.57	1.02	1.18	1.26	1.35
P.C. ....	.2556	.3015	.2358	.6566	.2510	.2515	.2011	.1839	.2698	.1951
Range ...	4-19	3-13	2-9	0-7	5-20	18-48	16-34	12-48	0-38	22-48

## GROUP OF 20 MEN—RECOGNITION SET A, RECALL SET B

	Words	Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Av. ....	7.50	6.45	6.10	3.05	8.80	27.50	24.65	34.20	23.35	30.80
P.E. ....	.43	.39	.37	.27	.43	.80	1.46	1.22	1.28	1.19
P.C. ....	.3000	.3178	.3333	.4328	.2602	.1545	.3119	.1889	.2903	.2039
Range ...	3-51	2-10	1-9	0-7	5-17	10-44	6-40	22-42	8-38	16-50

## GROUP OF 20 WOMEN—RECALL SET A, RECOGNITION SET B

	Words	Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Av. ....	10.35	6.85	6.10	4.00	13.70	35.60	14.75	33.75	20.30	36.90
P.E. ....	.64	.37	.25	.23	.53	1.84	.95	1.20	1.51	1.33
P.C. ....	.3217	.2847	.2197	.3000	.2051	.2736	.3424	.1882	.3980	.1900
Range ...	4-18	4-12	4-9	2-9	8-20	17-48	4-24	22-44	6-44	24-48

## GROUP OF 20 MEN—RECALL SET A, RECOGNITION SET B

	Words	Forms	Proverbs	Syllables	Words	Words	Forms	Proverbs	Syllables	Words
Av. ....	7.90	7.45	4.90	3.25	10.20	29.45	12.90	32.10	17.00	29.90
P.E. ....	.46	.45	.25	.16	.56	1.42	.96	1.20	1.59	1.50
P.C. ....	.3051	.3168	.2878	.2554	.2882	.2547	.3954	.1900	.3296	.2656
Range ...	3-14	2-12	3-7	1-6	3-16	12-48	0-26	22-48	2-32	22-44

groups when the Pearson coefficient or the P.E. or the range are used as measures of variability.

In the tests for recall of words among the children, the Pearson coefficient of variability is greater for the girls in six of the ten cases; for recall of forms six of the ten coefficients are greater for girls; for recall of syllables seven of the ten coefficients are greater for girls. In the recognition of words the Pearson coefficient of variability for girls is greater than that of the boys' scores two of the ten times; in recognition of forms five of the ten times; in recognition of syllables once in the nine times. Of the fifty-eight coefficients of variability, twenty-seven show greater variability for boys.

Among the P.E. measures the girls' are higher than the boys' four of the ten times in the test for recall of words, three times out of ten in test for recall of forms and twice the scores are the same, eight times out of nine for the test in recall of syllables the girls' scores are higher; four of the ten times in recognition of words the girls are higher, and once the same for both, in test for recognition of forms three times out of the ten and in test for recognition of

TABLE XXII

## CHILDREN

	Recall Words			Recall Forms			Recall Syllables		
	Av.	P.E.	P.C.	Av.	P.E.	P.C.	Av.	P.E.	P.C.
4A B.....	4.12	.18	.3301	3.32	.17	.3916	1.54	.12	.6101
G.....	4.30	.17	.3279	4.30	.19	.3279	2.00	.15	.6200
4B B.....	4.41	.20	.2925	3.69	.23	.3225	1.51	.11	.4702
G.....	5.33	.23	.3246	3.33	.15	.3273	1.82	.15	.5789
5A B.....	5.18	.21	.3050	4.26	.20	.3451	1.74	.19	.8218
G.....	5.64	.22	.3103	4.15	.16	.3084	1.83	.14	.6393
5B B.....	5.66	.19	.2544	4.59	.21	.3508	2.27	.18	.6123
G.....	5.60	.24	.2750	4.00	.21	.3250	2.10	.17	.5650
6A B.....	5.69	.30	.3198	4.42	.24	.3303	1.81	.17	.4144
G.....	6.08	.26	.3076	4.95	.20	.2869	2.41	.19	.5560
6B B.....	6.36	.23	.2013	5.27	.22	.2941	1.86	.17	.5000
G.....	6.49	.19	.2182	5.22	.22	.3027	2.21	.16	.5112
7A B.....	6.48	.34	.3114	5.08	.14	.1673	2.24	.10	.2679
G.....	7.36	.42	.2269	4.55	.46	.3956	2.64	.26	.3902
7B B.....	8.18	.34	.2298	6.23	.21	.2071	3.00	.23	.3933
G.....	7.45	.32	.2847	5.77	.25	.2894	2.55	.22	.5255
8A B.....	6.78	.29	.2274	5.43	.24	.2431			
G.....	8.09	.28	.2410	5.38	.23	.2918			
8B B.....	6.63	.35	.2338	5.63	.23	.2096	2.84	.24	.4331
G.....	7.76	.30	.2332	5.24	.21	.2863	5.37	.37	.5028

	Recognition Words			Recognition Forms			Recognition Syllables		
	Av.	P.E.	P.C.	Av.	P.E.	P.C.	Av.	P.E.	P.C.
4A B.....	20.15	1.18	.4427	7.56	.83	.8307	6.95	.81	.8777
G.....	23.36	.97	.3485	8.16	.71	.7328	8.62	.85	.8260
4G B.....	14.79	1.35	.5842	8.10	1.03	.8136	2.45	.97	2.5266
G.....	23.32	1.34	.4250	5.36	.83	1.1567	10.26	.89	.6404
5A B.....	23.74	1.24	.3863	11.15	.81	.5399	7.34	.84	.8465
G.....	28.19	1.15	.3303	9.21	.67	.5094	10.68	.78	.6403
5B B.....	23.88	1.18	.3744	9.73	.82	.6362	9.98	.98	.7405
G.....	26.73	1.18	.2858	8.23	.83	.5747	9.60	1.08	.7281
6A B.....	29.38	1.27	.3261	11.88	.83	.4192	15.81	1.07	.4080
G.....	28.22	1.39	.3250	13.47	.95	.4996	15.83	1.16	.4068
6B B.....	24.45	1.45	.3292	10.36	1.13	.6071	11.41	.88	.4294
G.....	35.04	1.05	.2226	14.92	.78	.3807	13.19	.88	.4784
7A B.....	27.12	1.43	.3119	8.36	.58	.4103	11.24	1.16	.6112
G.....	32.73	1.87	.2215	8.09	1.09	.5266	12.55	1.77	.5546
7B B.....	24.04	1.11	.2558	9.77	.93	.5281	10.32	1.11	.5978
G.....	31.81	1.34	.2785	10.48	.83	.5248	14.06	1.26	.5925
8A B.....	29.62	1.29	.2366	12.14	1.01	.5461			
G.....	28.94	1.43	.3417	11.71	.97	.5730			
8B B.....	27.68	1.91	.3555	14.61	1.14	.4031	10.79	1.36	.6525
G.....	32.39	.95	.2146	11.48	.87	.5523	16.71	.98	.4261

syllables five of the nine times the girls are higher and once they are the same for both sexes.

Of the fifty-eight measures of the P.E. twenty-seven are greater for the girls' scores, four are equal for both boys and girls and twenty-seven are greater for the boys' scores.

No difference in variability between the boys and girls is apparent when the Pearson coefficient or the P.E. are used as measures of variability.

No sex difference in variability in these tests for recall and for recognition is present among adult nor among children.

### 8. *Age Differences in Recall and Recognition*

Is there any difference in recall among children of different ages regardless of class in school?—in recognition?

In Table XXIII. are the averages for each material, words, forms, and syllables, by each method of testing, recall and recognition, for each age. The number of children in each age-group is also given.

Each child was asked to state how old he or she was on the last birthday and when this birthday was. Since all children eight on their last birthday, nine on their last birthday, etc., are here consid-

TABLE XXIII

#### AGE DIFFERENCES

No. of Children	Age	Recall Words	Recall Forms	Recall Syl.	Recog. Words	Recog. Forms	Recog. Syl.
15	8.5	(4.60)	(3.27)	(1.00)	(18.13)	(5.40)	(9.80)
82	9.5	4.70	3.36	1.68	21.49	8.70	7.49
120	10.5	5.41	4.10	1.86	24.49	9.65	9.56
130	11.5	5.56	4.54	2.03	25.87	11.08	11.17
110	12.5	5.85	4.64	2.28	26.08	9.55	11.17
91	13.5	7.16	5.33	2.38	29.54	9.56	11.77
62	14.5	7.19	5.51	2.86	31.24	12.58	13.23
27	15.5	8.33	5.41	1.91	35.39	10.26	14.32
9	16.5	(6.11)	(5.11)	(1.43)	(24.55)	(9.11)	(6.67)
2	17.5	(10.00)	(6.00)	(5.00)	(39.00)	(11.00)	(15.00)

ered "eight-year-olds," "nine-year-olds," etc., the meaning of eight-year-olds, nine-year-olds, is 8.5, 9.5, etc., in this report. Furthermore, all eight-year-olds, nine-year-olds have not been tested, so that the averages are for the eight-year-olds, nine-year-olds, etc., who were tested in the grades 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B. There is a marked selection in the case of eight-year-olds, sixteen-year-olds, and seventeen-year-olds; the results for them are therefore given in parenthesis and are not included in the diagram. Only fif-



teen of the one hundred and fifty-nine in the fourth year (4A and 4B) are eight years old, most of the children of that grade being at least nine years old. Due to the laws permitting children of fourteen who have reached a certain grade to obtain "working papers," to the fact that most children of sixteen and seventeen have completed grade 8B, and to other causes, only eleven children of sixteen and seventeen are among the children in the seventh and eighth grades (7A, 7B, 8A, 8B).

The scores for recall and for recognition of words increase gradually from the age of 8.5 through 15.5. In general, there is a tendency for improvement with age for recall and for recognition of forms and syllables also. The improvement with age may be seen by comparing the average of the averages for ages 9.5, 10.5, 11.5 with the average of the averages for ages 13.5, 14.5, 15.5. The average of the average scores for ages 9.5, 10.5, 11.5 for recall of words is 5.22 and the average of the average scores for ages 13.5, 14.5, 15.5 for recall of words is 7.22. For recognition of words the first average is 23.95 and the second 28.95. For the recall of forms the scores are 3.97 and 5.42 respectively, and for recognition of forms 9.61 and 10.8. In the tests for syllables recall averages 1.86 and 2.38 respectively and for recognition 9.41 and 13.11 respectively. For all materials and for recall and recognition the scores are higher for the older ages than for the younger ones. Both recall and recognition scores seem to improve with age.

### 9. Grade Differences in Recall and Recognition

Is there any difference in recall among children of different grade regardless of age?—in recognition?

In Table XXIV. the averages are given for each material in each grade.

TABLE XXIV

	Recall Words		Recall Forms		Recall Syllables	
	Av.	M.V.	Av.	M.V.	Av.	M.V.
4A .....	4.22	1.44	3.40	1.32	1.79	1.12
4B .....	4.94	1.60	3.48	1.30	1.69	.89
5A .....	5.43	1.67	4.15	1.28	1.79	1.28
5B .....	5.63	1.49	4.33	1.53	2.20	1.28
6A .....	5.92	1.87	4.73	1.46	2.16	1.23
6B .....	6.44	1.35	5.24	1.55	2.08	1.03
7A .....	7.03	1.92	4.97	1.69	2.36	1.19
7B .....	7.75	2.00	5.96	1.48	2.74	1.30
8A .....	7.62	1.93	5.40	1.48		
8B .....	7.39	1.77	5.37	1.41	3.07	1.50



TABLE XXIV.—*Continued.*

	Recognition Words		Recognition Forms		Recognition Syllables	
	Av.	M.V.	Av.	M.V.	Av.	M.V.
4A .....	21.91	8.76	7.98	6.09	7.87	6.01
4B .....	21.09	9.65	7.72	6.07	6.87	6.49
5A .....	26.19	9.90	10.09	5.68	10.51	6.37
5B .....	25.08	7.94	9.10	5.42	9.81	7.13
6A .....	28.71	10.17	12.77	6.05	15.82	6.41
6B .....	31.10	7.80	13.22	6.02	12.86	5.76
7A .....	28.83	8.22	8.28	5.68	11.64	6.91
7B .....	28.59	9.03	10.19	5.50	12.51	7.65
8A .....	29.20	8.37	11.87	6.61		
8B .....	30.82	8.48	11.48	6.34	14.74	7.41

There is a tendency for the scores to improve gradually from grade 4A through 8B for recall and for recognition of words, forms, and syllables. This tendency is more evident when the average scores for 4A, 4B, 5A, 5B, 6A are compared with the average of the scores for 6B, 7A, 7B, 8A, 8B. For recall of words these scores are 5.23 and 7.25 respectively, for recognition of words 24.59 and 29.71 respectively, for recall of forms 9.53 and 11.01 respectively, for recall of syllables 1.93 and 2.05 respectively, for recognition of syllables 10.18 and 12.94 respectively.

The tables also show the general tendency of improvement from 4A through 8B in both recall and recognition for words, forms, and syllables.

### 10. *Age and Grade Differences*

Since the tables and curves for grade tend to show an improvement with advance in grade and the tables and curves for age tend to show an improvement with age, it is possible that both grade and age have their influence. This leads to the question: Do the youngest children in each grade have the best or worst scores? Do the oldest children in each grade do best or worst in memory tests? Do the children whose age is the same as most of the other children in their grade have the best, medium, or worst scores?

The following method of scoring was adopted. One step in age is one year, 8 to 9, 9 to 10, etc., and for grade the step used is one year, 4 to 5 (4A, 4B), 5 to 6 (5A, 5B), 6 to 7 (6A, 6B), 7 to 8 (7A, 7B), 8 to high school (8A, 8B). The following table (XXV.) shows the number of children of each age in each grade.

The medium for grade 4 is at age 9.5, for grade 5 at 11.5, for grade 6 at 11.5, for grade 7 at 13.5, for grade 8 at 14.5. By adding

TABLE XXV

Age	4	5	6	7	8	Total
8.5	15					15
9.5	68	14				82
10.5	52	55	12	1		120
11.5	16	53	50	6		130
12.5	5	23	33	25	14	100
13.5	3	4	18	32	34	91
14.5		1	6	16	39	62
15.5		2	2	8	15	27
16.5				1	8	9
17.5					2	2
	159	157	121	89	112	638

the scores for the recall of words of the nine year olds for grade 4, of the eleven year olds for grade 5, of the eleven year olds for grade 6, of the thirteen year olds for grade 7, and of the fourteen year olds for grade 8, the total score of those who are in a grade where the median age is their age, was obtained. By dividing this total by the total number of persons whose scores have been added, the average score for the children who are in a grade where the median age is their age is found. Then the scores of those who are one year, two years, etc., older and one year, two years, etc., younger than the median age for their grade may be computed. Thus the tabulation for the recall of words is:

SCORES							
-3	-2	-1	0	1	2	3	4
		69	320	225	74	23	9
	65	324	304	132	22	7	13
		79	305	194	115	39	15
11	40	181	252	115	60	8	
	114	257	285	127	47	20	
11	219	910	1466	793	318	97	37
SUBJECTS							
-3	-2	-1	0	1	2	3	4
		15	63	52	16	5	3
	14	55	58	23	4	1	2
		12	50	33	18	6	2
1	6	25	32	16	6	1	
	114	34	39	15	8	2	
1	34	141	247	139	54	15	7
Av. 11.00	6.44	5.45	5.93	5.70	5.88	5.47	5.30

The averages for the six tests are given in Table XXVI.

TABLE XXVI

	-3	-2	-1	0	1	2	3	4
Recall Words . . . . .		6.44	6.45	5.93	5.70	6.47	6.47	5.30
Recall Forms . . . . .	6.00	5.36	4.87	4.51	4.45	4.60	4.60	3.57
Recall Syl. . . . .	0.00	2.65	2.49	2.26	2.19	2.87	2.87	2.43
Recog. Words . . . . .	44.00	25.38	26.71	26.55	24.76	29.13	29.13	31.85
Recog. Forms . . . . .	16.00	10.50	10.58	10.53	8.61	11.67	11.67	7.71
Recog. Syl. . . . .	12.00	13.74	12.66	10.73	10.17	9.69	6.07	9.57

The score under zero is that of the children who are in a grade where the median age is their age, under - 1 is the score of the children who are one year younger than the median, under 1 is that of the children who are one year older than the median for their grade, etc.

It is evident that the oldest children in a grade, on the average, do not have the best scores, but they do not always have the worst scores. The children at the median age for their grade do not have the best nor the worst scores. There is a tendency for the scores of those who are younger than their classmates to be higher, except in the case of syllables, but the number of subjects is small in the group under - 3. The curves and the tables suggest that there is a tendency toward improvement by age and by grade.

11. Group Differences in Recall and Recognition

TABLE XXVII

	Recall					Recognition				
	Words	Forms	Prov.	Syl.	Wds.	Wds.	Forms	Prov.	Syl.	Wds.
Grad. Stud. Av. . . . .	8.53	7.00	5.13	3.33	10.40	31.60	18.55	32.58	11.90	33.98
Undergrad. Av. . . . .	9.10	6.63	6.00	3.13	11.15	31.18	21.00	34.53	21.55	33.13

In Table XXVII. the results of the graduate and undergraduate students are given. Graduate students are a selected group of college graduates, but no marked difference in achievement is noticed in any of the memory tests between them and the undergraduate students. There is a marked difference between the college and university students and the school children. The children's group is not so selected as the adults' group.

The differences are present or absent in the same way for recall and recognition.

## CHAPTER VI

### MEMORY TESTS OF INSANE PATIENTS

BOOKS on psychiatry often mention memory defects among insane patients. Little is said whether the defect is for both recall and recognition.

To attempt to see if any differences in recall and in recognition could be observed among insane patients, the tests used on the normal subjects were given to several patients in a hospital for the insane. The cases will first be considered separately.

Several patients known as Korsakoff's were tested.

M-1 male, adult, exact age unknown. Korsakoff Disease.

*Recall scores:* Words 12, Forms 6, Proverbs 2, Syllables 0, Words 1.

*Recognition scores:* Words 12, Forms 6, Proverbs 14, Syllables 6, Words 6.

The patient was born in this country and formerly had been in business. He was pleasant and coöperated well in the tests, for he was anxious to leave the hospital and go to work. The picture had been shown to him for fifty seconds before the tests were made so that he might have some idea of the length of the period. After the ten memory tests were made, the examiner asked him if he remembered her showing him a picture. He did not, but when shown the picture again he said he remembered having seen it when he first came into the room.

The examiner showed him six cards (5 by 8 inches) on each of which was pasted an object (big blue *B*, a red postage stamp, a dish of cereal, man's head, baby and dog, watch). Each card was shown for two seconds. Immediately afterwards they were mixed with six more cards, each having a picture. He was asked to select all which he had seen. He recognized the first, second, third, and sixth, a total of four. He asked if they were right.

M-2 male, age 62.

*Recall scores:* Words 3, Forms 1, Proverbs 1, Syllables 1, Words 3.

*Recognition scores:* "I don't remember ever having seen them."

This patient when examined (1915) had been in the hospital for seven years but did not know how long. The records show that in 1913 he knew he had come in 1908. The patient in his youth, had



attended a well known American university; later he had been a ticket seller. The hospital records call his case "residual of alcoholic Korsarkoff psychosis."

After studying the presented series for fifty seconds he could not recognize anything—this was true for all the materials. He would say, "I don't remember ever having seen any. Isn't that extraordinary?" In the test for recall he remembered three words, one form, one proverb, one syllable, three words.

He was shown the six cards mentioned above, one every two seconds. They were mixed with six other cards on each of which was pasted the picture of objects and from the twelve he was asked to select those that he had seen. He said that he did not remember having seen any. This test was extremely easy as the six objects seen, including a red postage stamp and a large blue *B*, could easily be distinguished by most persons.

F-1 Female, age 66, religion: Roman Catholic. Occupation: cook. Born in the U. S.; single. Korsakoff disease.

*Recall scores:* Words 4, Forms 0, Proverbs 2, Syllables 1, Words 3.

*Recognition scores:* Words 16, Forms 6, Proverbs 16, Syllables 2, Words 14.

The patient had been addicted to use of alcohol for a great many years and used it to excess between 55 to 65 years of age. She fabricates and has very defective judgment, according to other examiners. Physically some evidence of an arterio-sclerotic condition had been found.

She could write her name, but did it very poorly. The material had to be presented auditorially. The six cards mentioned above were shown and the first, second, fifth, and sixth correctly selected from the twelve afterwards, *i.e.*, four out of six were recognized.

F-2 Female, age 36 or 39. Born in Ireland; in U. S. about 14 years; religion: Roman Catholic. Occupation of husband: general laborer. Korsakoff disease.

*Recall scores:* Words 2, Forms 0, Syllables 0, Proverbs 2, Words 1.

*Recognition scores:* Words 6, Forms 6, Syllables 0, Proverbs 0, Words 0.

The patient probably had very little schooling; she can not write her own name. She has indulged excessively in alcoholics and has physically signs of neuritis.

The patient could read, but wrote poorly and slowly. The experiment was therefore conducted by letting the patient study the presented lists, but recall orally. She recalled two words from the first



series, the last two on the list. She attempted to draw the forms but only made a mark resembling the letter H. She understood the proverbs and recalled two. In trying to recall the syllables she mentioned several combinations of letters, but none was correct. After the second series of words, she mentioned five words, but only one from the second list, one from the first list and three which had appeared on no list so far shown; thus her response was: carriage, stove, white, pipe, mirror. For the recognition tests the patient saw the material and answered whether or not she had seen it on the other list, the examiner recording the reply.

The patient coöperated well. She was sad, however, and moaned. Before the test materials were presented she was shown a picture for fifty seconds. Forty minutes later she was asked if she had been shown a picture. When presented again, she said she had not seen it before. She pointed out several objects on the picture indicating that she could see them.

F-3 Female, age 38. Born in Ireland; in U. S. about 16 years. Occupation of husband: coachman. Korsakoff.

*Recall scores:* Words 5, Forms 0, Proverbs 0, Syllables 0, Words 3.

*Recognition scores:* "No."

During the examination she remarked several times that she had never had any schooling because she had to work out, adding, "It's a sad thing indeed to have no schooling." She cried frequently because she was so happy, saying, "I thought I was in the bad house but I came to myself to-day and know it's not the bad house." She could neither read nor write so that the material was presented auditorially. She recalled three words. Although she could not write she drew two figures, but they were not like those shown. The proverbs seemed familiar, she often would finish one in chorus with the examiner. She could recall only two. The syllables could not be presented in a satisfactory manner. She recalled three words from the second set. In the recognition tests she would say "Yes" or "I'm not sure Ma'am."

M-3 Male, age 55. Born in Germany, in U. S. 20 years. Occupation: baker. Alcoholic psychosis.

*Recall scores:* Words 4, Forms 0, Proverbs 0, Syllables 0, Words 3.

*Recognition scores:* Words 22, Forms 0, Proverbs 0, Words 15.

The patient could not remember the doctor's name ten minutes after having said it three times. He said the forms were French.

M-4 Male, general paralysis.

*Recall scores:* Words 1, Forms 2, Proverbs 0, Words 1.

*Recognition scores:* Words 2, Forms 2, Proverbs 2, Words 2.  
The patient could not do the syllable test.

M-5 Male. General paralysis with slight intellectual defect.

*Recall scores:* Words 1, Forms 4, Proverbs 1, Syllables 0, Words 4.

*Recognition scores:* Words 8, Forms 6, Proverbs 26, Syllables 8, Words 20.

The patient coöperated *very* well. He was pleasant, willing and tried to do his best.

Thirty minutes after having seen the picture which had been shown for fifty seconds, he remembered having seen it and named the objects in it. After having seen the six cards mentioned above he was able to select five from the series of twelve.

M-6 Male. General paralysis.

*Recall scores:* Words 6, Forms 0, Proverbs 0, Syllables 0, Words 5.

*Recognition scores:* Words 6, Forms 8, Proverbs 12, Syllables 8, Words 8.

He selected the first, second, third, fifth, and sixth items—*i.e.*, five of the six presented on the cards when they were mixed with the six others.

Thirty minutes after having seen the picture shown for fifty seconds he remembered and described it.

M-7 Male.

*Recall scores:* Words 6, Forms 4, Proverbs 1, Syllables 1, Words 4.

*Recognition scores:* Words 12, Forms 8, Proverbs 0, Syllables 0, Words 10.

He described the picture thirty minutes after having seen it for fifty seconds. He also selected six cards correctly from the set of twelve. His coöperation was good.

M-8 Male, brain syphilis.

*Recall scores:* Words 5, Forms 3, Proverbs 2, Syllables 2, Words 7.

*Recognition scores:* Words 6, Forms 6, Proverbs 10, Syllables 4, Words 10.

The patient coöperated well.

M-9 Male, age 60. Arterio-sclerosis. Occupation: singer.

*Recall scores:* Words 6, Forms 1, Proverbs 3, Syllables 2, Words 6.

*Recognition scores:* Words 16, Forms 6, Proverbs 32, Syllables 24, Words 32.

The patient was pleasant and tried to do his best. He remembered having seen the picture thirty minutes afterwards. He thought it was a picture of a little girl but could not say what was beside her. He recognized all six of the six cards in the series of twelve.

M-10 Male, age 63. Arterio-sclerosis. Born in U. S. Common school education; left school at age of 14. Occupation had been machinist, grocer, and salesman.

*Recall scores:* Words 3, Forms 0, Proverbs 4, Syllables 0, Words 10.

*Recognition scores:* Words 16, Forms 8, Proverbs, Syllables 0, Words 10.

He remembered the picture and could describe it twenty-five minutes after having seen it. He recognized five of the six cards correctly in the series of twelve.

M-11 Male, age 53. Arterio-sclerosis. Born in U. S.; high school education. Occupation: advertising agent, said to have earned \$5,000 a year as secretary to a publishing house at one time.

*Recall scores:* Words 4, Forms 2, Proverbs 0, Syllables 0, Words 2.

*Recognition scores:* Words 10, Forms 4, Proverbs 6, Syllables 0, Words 12.

He remembered and could describe the picture thirty minutes after having seen it for forty seconds. He also selected the six cards correctly from the series of twelve.

M-12 Male, age 56. Arterio-sclerosis. Common school education. Occupation: carpenter.

*Recall scores:* Words 3, Forms 0, Proverbs 0, Words 1.

*Recognition scores:* Words 23, Forms 4, Proverbs 0, Words 4.

The materials, except forms, were presented verbally. The tests for syllables were not given.

He could select the six cards correctly from the series of twelve.

A few cases of senile dementia are described below:

F-5 Female, age 79 or 84 (she does not know). Senile. Born in Ireland; in U. S. 60 years.

The material was presented auditorially. She could not recall any of the material nor could she recognize any, as may be seen by the scores for recognition—Words 6, Forms 2, Proverbs 0, Words 6.

She could remember nothing in the picture a half hour after it had been shown to her. After seeing the six cards mentioned above she selected ten among the twelve as those previously seen.

F-6 Female, age 81. Occupation: housework. Religion: Methodist. A typical "dear old lady."

She could not see well enough to read the print nor hear. The examiner was unable to conduct the experiment, except the six cards were shown and afterwards she selected four from the series of twelve.

A few other cases not easily diagnosed are given :

M-13 Male, age 54.

*Recall scores:* Words 3, Forms 0, Proverbs 0, Syllables 1, Words 2.

*Recognition scores:* Words 10, Forms 0, Proverbs 6, Syllables 6, Words 16.

When attempting to recall words the patient mentioned several that had not been presented.

M-14 Male, age 54.

*Recall scores:* Words 2, Forms 0, Proverbs 0, Words 1.

*Recognition scores:* Words 12, Forms 4, Proverbs 12, Words 14.

The data of all the cases are not comparable for the conditions of the experiment were not the same for each patient. Some of the patients were unable to see well and for them it was necessary to vary the conditions and present the material auditorially. When it was possible the conditions were kept like those for the normal subjects to whom the materials were always presented visually. The patients differ in age, in amount of education which they have had, in previous experience and environmental conditions. They all have not the same mental disorder, nor are those whose disorders are similar all in the same stage of the disease. M-1, for example, has been diagnosed alcoholic psychosis-Korsakoff disease. He was greatly improved and allowed to leave the hospital shortly after these memory tests had been made. F-2 and F-3 were in more advanced stages of the Korsakoff disease and in each case the prognosis was poor.

No attempt will be made, therefore, to average the results of the subjects in this group of insane patients, but from the following table one can compare the results of those having Korsakoff disease, general paralysis, and arterio-sclerosis. All show a memory defect and the defect is present in both recall and recognition.

In general, from these data, there is little difference in recall among the patients suffering from general paralysis and arterio-sclerosis. In recognition, there is no difference except in the case of words for which the arterio-sclerosis patients score higher. The scores of the Korsakoffs are increased when those of patient M-1 are included. Omitting the records of M-1 who was recovering and about to leave the hospital, one finds the scores among the Korsakoffs lower than those among the general paralysis and arterio-sclerosis cases. These patients were less able to attempt the tasks. There is no striking difference between the way the diseases affect the recall and recognition.



TABLE XXVIII

KORSAKOFF

*Recall*

	M-1	M-2	M-3	F-1	F-2	F-3	F-4
Words .....	12	2	4	4	2	5	3
Forms .....	6	1	0		0	0	0
Proverbs .....	2	1	1	2	2	0	
Syllables .....	0	1	0	1	0	0	3
Words .....	1	3	3	3	1		

*Recognition*

Words .....	12		22	16	6
Forms .....	6		0		6
Proverbs .....	14		0	16	0
Syllables .....	6			2	0
Words .....	10		15	14	0

Recog. of 6 out of 12 pictures .... 4 0 0 4

*Recall*

General Paralysis				Brain Syphilis	Arterio-Sclerosis			
M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11	M-12
1	1	6	6	5	6	3	4	3
2	4	0	4	3	1	0	2	0
0	1	0	1	2	3	4	4	0
		0	1	2	2	0	0	
1	2	5	4	7	6	5	2	1

*Recognition*

2	8	6	12	6	16	16	10	23
2	6	8	8	6	6	8	4	4
2	26	12	0	10	32	8	6	0
	8	8	0	4	24	0	0	
2	20	8	10	10	32	10	12	4

Recog. of 6  
out of 12  
pictures

5 5 6 6 5 6 6



## CHAPTER VII

### RECOGNITION

INTEREST in the process of recognition has been shown recently. In the present study of recall and recognition the data on recognition may be examined with interest apart from its relation to recall. Each subject was shown twenty-five items and in the recognition test was given fifty and asked to indicate which he thought had been shown before by writing "YES" before them and before those which he thought had not been shown, "No." Twenty-five of the fifty items had been on the list previously seen and twenty-five had not been seen before.

An examination of the data will show

1. The comparison between the number of the YESes and Nos used for each material.

2. The per cent. of wrong YESes and right YESes among all the YESes used; the per cent. of wrong Nos and right Nos among all the Nos used.

3. The comparison of the per cent. of wrong YESes among all responses with the per cent. of wrong Nos to all responses.

4. The per cent. of all the responses correct for each material.

5. The comparison of the per cent. of wrong YESes among the men and among the women; the comparison of the per cent. of wrong Nos among the men and women.

6. The comparison between men and women of the number of wrong YESes among the total number of YESes used, the comparison between men and women of the wrong Nos among the total number of Nos used.

7. The comparison of *old* and *new* judged correctly.

1. *The Comparison of the Number of Yeses and Nos Used for Each Material*

More Nos are used than YESes in all of the tests. The difference is less for words than for the other materials. There is no consistency between the two sets of the same material, however. Proverbs have differences between YESes and Nos used of 399 and 385 in the first and second sets respectively; syllables have differences 490 and 299

in the first and second sets respectively when the total number of responses is 2,000.

2. *The Per Cent. of Wrong Yeses and Right Yeses Among All the Yeses Used; the Per Cent. of Wrong Nos and Right Nos Among All the Nos Used*

A larger number of Nos are wrong than YESES. This might be expected since more Nos are used than YESES. This is true for each of the ten tests. The amount of difference varies in the first group from 130 to 230 and in the other from 86 to 177. The differences are not consistently large or small for any material. The greatest difference, 230, between the wrong Nos and wrong YESES in the first group and the least difference, 86, in the second group are in the tests for syllables.

The per cent. of wrong YESES among all YESES used and the per cent. of wrong Nos among all Nos used are given in the table. In each of the ten cases the per cent. of wrong YESES is less than the per cent. of wrong Nos. The difference is not great; it varies in the second group from .5 per cent. to 15 per cent. and in the first group from 4.5 per cent. to 15 per cent. The difference in the first group for words is 8.5 per cent., for forms 4.5 per cent., for proverbs 15.5 per cent. and for the second series of words 11 per cent. In the second group the difference for words is 4.5 per cent., for forms 9 per cent., for proverbs 15 per cent., for syllables .5 per cent. and for the second series of words 9 per cent. The difference is greatest for proverbs in each case. In the first group the per cent. of wrong YESES is greatest for proverbs, next for forms, then for words, and least for syllables. In the second group the order is proverbs, words, syllables, forms. In an earlier chapter it was noticed that the difficulty of the two series of forms is not the same for recognition. If the forms are omitted from our lists here, and only the materials involving letters or words considered, the two lists have the same order—proverbs, words, syllables. Thus, from the data of this experiment it appears that among materials containing letters or words, the greatest per cent. of false recognition is found in that material where the greatest meaning is present. The per cent. of false recognitions decreases when the meaningful associations in the material decrease.

The range of the per cents of wrong Nos used in the first group is from 22 per cent to 28 per cent. and in the second group from 21.5 per cent. to 37.5 per cent. The range is smaller and therefore the difference between the materials is less for wrong Nos than for wrong

YESes. Forms in both groups lead the list in having the highest per cent. of incorrect Nos. Among the materials containing letters and words, syllables have the greatest number of wrong Nos and words and proverbs least. There is little or no difference in the materials in regard to per cent. of wrong Nos, except a possible tendency for the per cent. of wrong Nos to decrease with the increase of meaningful associations in the materials. These data show a tendency for increase in the per cent. of wrong YESes and a decrease in the per cent. of wrong Nos to occur with the amount of associations present, but the former is more evident than the latter.

TABLE XXIX

Yes Used	No Used	Wrong YESes	Wrong NOS	Wrong YES All YESes	Wrong No All Nos	Wrong Nos All Resp.	Wrong Nos All Resp.	% Correct Responses
910	1,074	158	235	17.5%	22.0%	8.0%	12.0%	84.0%
837	1,154	162	327	19.5%	28.5%	8.0%	16.5%	75.5%
804	1,189	68	244	8.0%	23.0%	3.5%	12.0%	84.5%
836	1,155	2,216	302	25.5%	26.0%	11.0%	15.5%	73.5%
886	1,008	112	226	13.0%	22.0%	5.7%	11.0%	73.5%
865	1,132	112.5	242.5	13.0%	21.5%	6.0%	12.5%	82.0%
844	1,147	280.5	428.5	33.0%	37.5%	14.0%	21.5%	64.0%
799	1,198	65.5	208.5	8.0%	23.5%	3.0%	14.0%	83.0%
754	1,244	196	426	26.0%	34.5%	10.0%	21.0%	69.0%
818	1,182	78	254	10.5%	21.5%	3.9%	12.9%	68.0%

The preceding table has compared the wrong YESes among all YESes used with wrong Nos among all Nos. The following table (XXX.) summarizes the data on the number of YESes and Nos used and expresses the relation of *right* YESes to all YESes and right Nos to all Nos. In eight of the ten cases the per cent. of right YESes among all YESes is higher than the per cent. of right Nos among all Nos, in one case they are equal, and in one case less. These tables also show the per cent. of right responses among the old and new items. "Old" items are those which have been shown before and "New" items are the control items which had not been seen before. The correct responses to "old" items is YES and to "new" items No. In each of the ten cases the per cent. of right responses among the new items is greater than among the old. The difference between the per cents varies from 5 to 25 per cent. The subjects appear to be more often correct in judging a thing as not seen before than as seen before.

TABLE XXX

RECOGNITION WORDS

	First Set, First Series				First Set, Second Series			
	Old	New	Total	% Right	Old	New	Total	% Right
Yes . . . . .	740	78	818	90	752	158	910	83
No . . . . .	254	928	1,182	79	235	839	1,074	78
Total . . . .	994	1,006	2,000		987	997	1,984	
% right ..	76	92			76	84		

	Second Set, First Series				Second Set Second Series			
	Old	New	Total	% Right	Old	New	Total	% Right
Yes . . . . .	852.5	112.5	765	87	774	112	886	87
No . . . . .	242.5	889.5	1,132	79	226	882	1,008	87
Total . . . .	995	1,002	1,997		1,000	994	1,994	
% right ..	76	89			77	89		

RECOGNITION FORMS

	First Set				Second Set			
	Old	New	Total	% Right	Old	New	Total	% Right
Yes . . . . .	563.5	280.5	844	66	672	162	834	86
No . . . . .	428.5	718.5	1,147	63	327	817	1,144	71
Total . . . .	992	999	1,991		999	989	1,978	
% right ..	57	72			67	83		

RECOGNITION PROVERBS

	First Set				Second Set			
	Old	New	Total	% Right	Old	New	Total	% Right
Yes . . . . .	733.5	65.5	799	97	736	68	804	91
No . . . . .	208.5	989.5	1,198	83	244	945	1,189	79
Total . . . .	942	1,055	1,997		980	1,013	1,993	
% right ..	78	94			75	93		

RECOGNITION SYLLABLES

	First Set				Second Set			
	Old	New	Total	% Right	Old	New	Total	% Right
Yes . . . . .	558	196	754	74	534	302	836	64
No . . . . .	426	818	1,244	66	216	939	1,155	81
Total . . . .	984	1,014	1,998		750	1,241	1,991	
% right ..	56	81			71	76		

3. *The Comparison of the Per Cent. of Wrong Yeses Among All Responses with the Per Cent. of Wrong Nos to All Responses*

Table XXIX. shows the per cent. of wrong YESes among all YESes and the per cent. of wrong Nos among all Nos. The per cent. of wrong YESes among all YESes varies in the first group from 3 to 14 per cent. and in the second group from 3.5 to 11 per cent. From the



data of this experiment for both groups it appears that among materials containing letters or words, the highest per cent. of correct responses is for proverbs, and the lowest per cent. for syllables. Proverbs offer the greatest number of associations, then words, and syllables the least. The per cent. of wrong Nos among all responses varies in the first group from 12.7 per cent. to 21.5 per cent. and in the second from 11.9 per cent. to 16.5 per cent. The variation between the materials is less than it is for the per cent. of wrong YESes among all responses. Among the materials, containing letters and words, proverbs have the highest per cent. of errors among the Nos and syllables the least. The order from highest to least per cent. of errors is the same for both sets—proverbs, words, syllables.

The per cent. of wrong Nos among all the responses is greater in each of the ten cases than the per cent. of wrong YESes.

#### *4. The Per Cent. of All the Responses Correct for Each Material*

The per cent. of all the correct responses among all the responses is given in the last column of Table XXIX. According to the formula used, 50 per cent. would indicate a zero score and 100 per cent. a perfect score. The range in the first group is from 73.5 per cent. to 84.5 per cent. and in the second group is 64.5 per cent. to 83 per cent.—the order from highest to lowest for materials containing words and letters is proverbs, words, and syllables. The materials rich with associations are better recognized than materials where associations are few.

#### *5. The Comparison of the Per Cent. of Wrong Yeses Among the Men and Among the Women*

The data mentioned above have been for the two groups of adults. In each group are twenty men and twenty women. The scores for the men and for the women are given separately in Table XXXI., M. indicating male and F. female.

In the ten cases stating the per cent. of wrong YESes among all the YESes, the men have a higher per cent. than the women, in one case they are the same and in one case the per cent. of wrong YESes for women is higher. Thus in eight out of the ten tests the women made few mistakes in selecting an item as one seen before.

The per cent. of wrong Nos among all the Nos used is also given in the table. In seven cases the per cent. of wrong Nos among all Nos is greater for men, in three cases it is greater for women. Thus in seven of the ten tests women make fewer mistakes than the men in selecting an item as one not seen before. In general the women are



TABLE XXXI

	Yeses Used	Nos Used	Wrong Yeses	Wrong Nos	Wrong Yes All Yeses	Wrong No All Nos	Wrong Yeses All Resp.	Wrong Nos All Resp.	%
F. . . . .	430	568	37	107	9%	19%	4.0%	11.0%	
M. . . . .	435	564	75.5	125.5	17%	24%	8.0%	14.0%	82.0%
F. . . . .	440	555	139.5	206.5	32%	37%	14.0%	21.0%	
M. . . . .	413	592	141	222	34%	38%	14.0%	22.0%	64.5%
F. . . . .	424	575	34.5	131.5	8%	23%	3.0%	13.0%	
M. . . . .	375	623	31	149	8%	24%	3.0%	15.0%	83.0%
F. . . . .	389	609	105	193	27%	32%	11.0%	19.0%	
M. . . . .	365	635	91	233	25%	37%	9.0%	23.0%	69.0%
F. . . . .	405	595	18	113	4%	19%	1.8%	11.3%	
M. . . . .	413	587	60	141	17%	24%	6.0%	14.1%	68.0%
F. . . . .	477	519	72	93	15%	18%	7.2%	9.3%	84.0%
M. . . . .	433	555	86	143	20%	26%	8.6%	14.3%	76.0%
F. . . . .	436	551	82	151	19%	27%	8.0%	15.0%	77.0%
M. . . . .	401	593	80	176	20%	30%	8.0%	17.6%	74.0%
F. . . . .	414	583	43	110	10%	26%	4.0%	11.0%	85.0%
M. . . . .	390	606	25	134	6%	22%	3.0%	13.0%	84.0%
F. . . . .	435	557	115.5	135.5	27%	24%	12.0%	14.0%	74.0%
M. . . . .	401	598	100.5	166.5	24%	28%	10.0%	17.0%	73.0%
F. . . . .	445	453	48	98	11%	21%	4.8%	10.9%	84.3%
M. . . . .	441	555	64	128	15%	23%	6.6%	12.9%	80.5%

superior to the men in the recognition of old items as old and of new items as new. By calculating the average per cent. of the wrong YESes among all YESes in the ten tests by women and by men the scores are 16.2 for the former and 18.6 for the latter or a difference of 2.4. The average per cent. of wrong Nos among all the Nos in the ten tests by women and by men are 24.6 for former and 27.6 for latter or a difference of 3.0.

6. *Comparison Between Men and Women*

In each of the ten tests the women have a higher per cent. of correct responses than the men. The difference between the sexes varies from 1 per cent. to 6.4 per cent. in the second group and from 2 per cent. to 7 per cent. in the first group. The women recognize better than the men do as it has been seen in Chapter V.

7. *The Comparison of Old and New Judged Correctly.*

How many old are judged correctly? How many new are judged correctly? The correct response to the OLD is YES and to the NEW is NO. The data show that more YESes for old occur than Nos for new—that is, the new are right oftener than the old. The new make a distinct impression and the subject responds with more certainty.

Among the old ones are failures of recognition but among the new are few false recognitions. Nos are used oftener than YESes and more Nos are wrong. When YES is used the subject has a fairly clear recognition. The Nos include errors due to failure to recognize but the YESes do not include many new not recognized.

#### METHODOLOGY OF SCORING

In scoring for recognition the score of the positive and the score of the negative should be considered. The right YESes minus the wrong YESes equals the score of the positive; the right Nos minus the wrong Nos gives the score of the negative. The sum of the score of the positive and the score of the negative equals the Recognition Score.

#### “NEGATIVE” RECOGNITION

In positive recognition the answer YES is given to an item which is *old*. We recognize it as something familiar. In so-called negative recognition the answer is No to an item which seems new. There is a “newness for the new” which leads to the conclusion that the item has not been seen before. This strangeness or newness appears to be a positive thing. “Negative” recognition is not always the mere casting aside of something which lacks familiarity but rather something which possesses a “newness” or strangeness.

## CHAPTER VIII

### CONCLUSIONS

THE present study has been interested in the two methods of testing memory, recall and recognition. To reproduce or recall what one has seen or heard is different from recognizing it as something previously seen or heard when it is presented again. To the writer both experiences equally seem to deserve the term memory, but the terms recall or reproduction and recognition should be used to distinguish them.

The results of the foregoing experiments on recall and recognition may be summarized as follows:

1. More items are recognized than recalled. The difference in recall and recognition memory is in part dependent on the richness of associations present.

2. Determined recall differs from undetermined recall more than determined recognition differs from undetermined recognition. In the tests where the subjects did not know that their memory would be measured the records are for undetermined recall and undetermined recognition, and in the tests where the subjects were aware that their memory was to be tested, the records are for determined recall and determined recognition. The difference between the records when the subjects knew and when they did not know their memory was being tested is greater in the tests for recall than in the tests for recognition.

3. The difference between recall and recognition is greater when the subjects did not know that their memory was to be tested than when they did know.

4. The influence of a determining factor is greater for the recall of material rich with associations than for material devoid of them. The advantage of making the observer determine to remember the material presented is greater when the material is meaningful and rich with associations than when it is nonsense. There is more difference in the scores for photographs than for nonsense syllables.

5. The determining factor influences the amount of the material remembered which can be correctly associated with other material remembered. The subjects could name the photographs better when they had tried to remember names and faces. This might have interesting applications in daily life. People who say that they can

not remember names and faces might be able to if they added more determination to remembering them and established associations between names and faces.

6. Primacy and recency both influence recall memory. The influence of each on recognition is less than on recall, but greater for material devoid of associations and less for material rich with associations.

7. Color variation does not increase the number of syllables recalled nor recognized so far as the results of this experiment show.

8. The variation in size of the syllables gave a higher score on the average than when the syllables were all the same size, but the difference is hardly significant.

9. The data indicate that a person who recalls a material well may recognize that kind well, fairly well, or poorly—we know little about one's recognition memory from a test of recall. There is a tendency, in general, for the correlation to be positive rather than negative.

10. The coefficients of correlation between recall of different materials show that a person who recalls one material well may or may not recall another material well. There is a tendency for the correlation to be positive rather than negative. There is little difference in materials, but among the adults tested, words are a better index of recall memory than the other materials.

11. The correlation between recognition of different materials is low. The person who recognizes one material well may or may not recognize another material well. There is a tendency for the coefficients of correlation to be positive rather than negative.

The correlation between recognition of different materials is about the same as the correlation between recall of different materials.

12. Some materials are more easily recalled than others. Some materials are more easily recognized than others. The number recognized is somewhat dependent upon how much confusion arises between the items previously seen and the new or control items. In general, for both recall and recognition the material with the greatest number of associations is remembered most easily and that with few or no associations is remembered poorly.

13. Among the adults tested the women appear to be superior to the men, on the average. The tendency for the women's scores to be higher is greatest in the scores for recall and recognition of words and in the recall of proverbs. The data show a tendency for girls to be superior to boys. This is in accordance with Pyle's experiments for recall of words where the norms for boys between the ages of



eight and eighteen are higher than those for the girls at the ages sixteen and seventeen only.

In general, there is no marked difference in achievement between recall and recognition for the sexes.

14. No difference in variability between the boys and girls is apparent when the Pearson Coefficient or the P.E. are used as the measures of variability. The coefficients of variability for adults are slightly higher for men but there is no striking sex difference.

15. For words, forms, and syllables for both recall and recognition the scores are higher for older ages than for younger ones. Both recall and recognition seem to improve with age.

16. There is a tendency for the scores to improve gradually from 4A through 4B for recall and for recognition of words, forms, and syllables, regardless of the age of the child.

17. The oldest children in a grade, on the average, do not have the best scores, but they do not always have the worst scores. The children at the median age for their grade do not have the best nor the worst scores. There is a tendency for the scores of those who are younger than their classmates to be higher, with the possible exception of syllables.

18. Among the insane patients tested there is no evidence of the disease influencing recall and recognition in different ways.

19. When the subject is asked to respond YES to items which he recognizes as seen before and NO to those not seen before, he responds NO more often than YES. The difference between the number of YESes and NOS used is less for words than for other materials. There is no consistency between the two sets of material, however. For example, the difference between YESes and NOS used in the tests for recognition of syllables are 399 and 385 and in the tests for recognition of syllables are 490 and 299.

20. A larger number of NOS are wrong than YESes. From the data of this experiment it appears that among materials containing letters or words, the greatest per cent. of false recognitions is found in that material where the greatest meaning is present. The per cent. of false recognitions decreases when the meaningful associations in the material decrease.

In each of the ten tests the per cent. of right responses among the new items is greater than among the old. The subjects appear to be more often correct in judging a thing as not seen before than as seen before.

21. The per cent. of wrong NOS among all the responses is greater in each of the ten cases than the per cent. of wrong YESes. Among



the materials containing letters and words, proverbs have the highest per cent. of errors among the Nos and syllables the least.

22. The new items are judged rightly oftener than the old are.

23. Women, in general, are superior to the men in recognition of old items as old and of new items as new in this experiment.

24. In each of the ten tests for recognition women have a higher per cent. of correct responses than men.

The writer has stated that both recall and recognition deserve to be included under the word memory. The field of memory might be illustrated by the crude simile of a bottle of milk—the method of recall measures those items which perhaps are the “cream.” The threshold for recall is high, but items which can not be recalled may be above the threshold for recognition, its threshold being far lower. Those items which we can not quite recall are easily recognized and lie just below the threshold for recall. Thus the two processes, recall and recognition, should not be thought of as in opposition or methods whose scores differ by a gap. The difference in our memory is one of degree—the item may be easily recalled, recalled with difficulty, easily recognized, recognized with difficulty. The difference may be expressed as a difference in the distance above the lower threshold of memory. How short the distance seems when a word “we can not just recall” is mentioned and we instantly say “That is it” when we hear it!

Both methods test our memory. We should be aware that the threshold for each is at a different level and choose the method of testing according to which measure we wish to obtain.

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## APPENDIX

The materials used which are reported in Chapter IV. were words, forms, syllables and proverbs. The words were simple nouns such as *flag, stove, hand*, etc. The forms were those used by Miss Whitley and printed in the Archives of Psychology No. 19. The syllables each had three letters, the first and third consonants, the middle one a vowel. The one hundred proverbs in the two sets of recognition series are appended.

Go farther and fare worse.  
Brave actions never want a trumpet.  
Too much rest itself becomes a pain.  
A broken sack will hold no corn.  
Feast to-day and fast to-morrow.  
Justice delayed is justice denied.  
Pleasing everybody is pleasing nobody.  
Genius is nothing but an especial talent for patience.  
Better go to bed supperless than rise in debt.  
All is not gold that glitters.  
A prophet hath no honor in his own country.  
Noblest minds are easiest bent.  
Happy is he who can live in peace.  
Smooth runs the water where the brook is deep.  
He who begins many things finishes few.  
Idle folks have the least leisure.  
One hour to-day is worth two to-morrow.  
Better twice remembered than once forgotten.  
Live to learn and learn to live.  
It is better to be sure than sorry.  
Pride joined with many virtues chokes them all.  
Keep your shop and your shop keeps you.  
It's an ill wind that does not blow someone good.  
Enough is as good as a feast.  
Great hopes make great men.  
An honest countenance is the best passport.  
Wilful waste makes woeful want.  
New occasions teach new duties.  
A stumble may prevent a fall.  
Caution is the parent of safety.  
The sweetest grapes hang highest.  
Haste trips up both its heels.  
Good counsel has no price.  
Experience is the best teacher.  
All is well that ends well.  
A stitch in time saves nine.

Better late than never.  
Gifts make beggars bold.  
Too far east is west.  
No news is good news.  
Offenders never pardon.  
Make hay while the sun shines.  
Look before you leap.  
The early bird catches the worm.  
Beggars cannot be choosers  
Many hands make light work.  
Easy come easy go.  
Guilt is always jealous.  
A bird in the hand is worth two in the bush  
Better ask than go astray.  
He who gives quickly, gives doubly.  
No road is long with good company.  
He who is well paid is well satisfied.  
You can force an ox to water but you can't make him drink.  
It never rains but it pours.  
A burnt child dreads the fire.  
A good hope is better than a bad possession.  
Company in distress makes trouble less.  
A full cup must be carried steadily.  
A friend in need is a friend in deed.  
Many cooks spoil the broth.  
Abundant caution does no harm.  
Practice makes perfect.  
Every hill has a valley.  
A small gift is better than a great promise.  
A golden bit makes none the better horse.  
A thing too much seen is little prized.  
Necessity is the mother of invention.  
One good turn deserves another.  
Don't cross the bridge until you come to it.  
A fog cannot be dispelled by a fan.  
One must cut his coat according to his cloth.  
All comes right to him who can wait.  
Those who climb high often have a fall.  
An empty bag cannot stand upright.  
Lazy folks take the most pains.  
A little spark kindles a great fire.  
A handful of common sense is worth a bushel of learning.  
Expect not at another's hand what you can do by your own.  
Spin not too fine a thread lest it break in weaving it.  
People who live in glass houses should not throw stones.  
Opportunity knocks but once, for the world hates a knocker.  
Birds of a feather flock together.  
A penny saved is a penny gained.  
Better cut the shoe than pinch the foot.  
Where everyone goes the grass never grows.  
There is no bush so small but casts its shadow.





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